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# Japan Report

(FOUO 43/82)



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POLITICAL AND SOCIOLOGICAL

TANAKA-FUKUDA CONFLICT ANALYZED

Tokyo BUNGEI SHUNJU in Japanese Jun 82 pp 232-236

[Article by Taro Akasaka: "The Curtain Raiser of the Fifth Fukuda-Tanaka War"]

[Text] "If Mr Fukuda is stopped and can do nothing it is clear that you, Mr Komoto, are the only person left. But in order not to create unnecessary trouble at that time, would you leave it to Fukuda for a while?"

This happened some time ago, but one day in March a "representative" of Takeo Fukuda visited Economic Planning Agency Director General Toshio Komoto and felt him out in this way. He presented the idea of an interim Fukuda government. Komoto replied, "I appreciate your consideration, but...." expressing thanks for the offer in a roundabout way.

This report has been going around recently, sending a shock through the red carpets of the Diet building.

Takeo Fukuda was born in 1905 and is 77 years old. He refers to himself as "the Komon of the Showa Period, deputy Shogun of the country." He has said that "the deputy Shogun does not do such foul things as trying to take power," and he speaks of "a well-seasoned state of mind." But everyone who hears the talk says, "So that's it. Fukuda's real aim was to come back as interim Shogun." In 1978, prior to the election for LDP president between Fukuda and the late Masayoshi Ohira, known as the Fukuda-Ohira war, Fukuda shouted the slogan: "The world is seeking Fukuda." This self-confidence has not diminished one bit.

Foreign Minister Yoshio Sakurachi, who is related to Fukuda by marriage, made a statement when he was chief secretary of the LDP that "Mr Fukuda has always come forth when there was a struggle in the party ever since the time of the Ikeda cabinet." Rokusuke Tanaka, chairman of the LDP political coordinating committee, who is known as "tricky Rokusuke" and pretends to be a bad guy, says, "It is frightening whenever Mr Fukuda begins talking about political ethics. A great disturbance is bound to occur."

Fukuda has stepped onto the political stage at every opportunity under the "banner of justice," calling for "purification of the political world" and "an end to money politics." He could be thought of as either a crusader or a troublemaker. Furthermore, a characteristic of Fukuda's words and actions is

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that they grow more extreme with the passage of time.

Because of this, Fukuda's actions and statements are always at the center of things in the political world. When Fukuda moves, it creates a stir in political circles.

Maneuvering in Preparation for a Terrible June

The first critical period for politics this year will be in June. A huge revenue shortfall, said to amount to 2.5 trillion yen, will become certain. The first trial decision for the Lockheed incident will be handed down for defendants Tomisaburo Hashimoto and Takayuki Sato. Trade tensions will increase. The Paris Summit, where Japan is expected to be attacked on this issue, will be held. There will be an explosion of all the difficult issues. Furthermore, the temporary administration study committee will make its report in July and Zenko Suzuki will be hit with a series of punches that will not give him time to breathe. There is maneuvering going on to remove Mr. Komoto from the cabinet during this "terrible June" on the pretext of maintaining cabinet unity in forming economic policies, and this will create a great commotion in political circles. Of course, the idea of "not removing Komoto" has gained acceptance, but in any case, June will be a month full of problems for Zenko Suzuki.

What concerns Fukuda and the Fukuda faction most right now is the revenue shortfall that will become apparent in June. Fukuda predicted at the first of the year that this will be "a year of great trouble in the country." As early as the end of January, he cautioned that "a movement will arise to ascertain political responsibility if a large revenue shortfall occurs."

On 9 April, Finance Minister Michio Watanabe clearly forecast that the revenue shortfall would be greater than 2 trillion yen. That night, Fukuda stated: "The amount is larger than expected. It cannot be handled with clever arguments. In 1982, the problem will become worse. There are three possible countermeasures, a cut in expenditures, increased issue of deficit-covering national bonds, or a tax increase. Suzuki has made a public commitment not to issue deficit-covering bonds or increase taxes, so the only thing he can do is cut expenditures drastically."

On the 13th, in explaining this problem, Watanabe said, "In making ends meet, the sources of many other problems could be created. It would not be right to use stop-gap tricks such as diverting debts from general accounts to special accounts or using the national debt adjustment fund or the settlement adjustment fund. Then it would be impossible to come up with a budget for 1983." Also, he emphasized that "it would be a mistake to go light on administrative reform because of the idea that it would lead to deflation. Drastic cuts in expenditures should be made."

Fukuda added: "There is a proposal for issuing more national construction bonds. However, construction bonds are debts just like the deficit-covering bonds. It would just be window dressing."

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On the night of the 6th when the 1982 budget was passed, both older and younger members of the Fukuda faction, including Minister of International Trade and Industry Shintaro Abe and LDP national organization chairman Mutsuki Kato held a meeting in a Tokyo restaurant. At this meeting, Abe began by saying, "The 1981 revenue shortfall will be huge. Rebuilding finances without a tax increase and reducing deficit-covering bond issues to zero by 1984 will be difficult. June will be full of problems such as trade tensions and an attempt to restore U.S.-Japan relations. It will be terrible." Those present responded by voicing strong views. "If the deficit-covering bond issue is increased, the Suzuki government's main drawing card will be destroyed." "It is time to take action. If things are left as they are, the people will desert the LDP." The main body and the younger members of the Fukuda faction, as well as the boss, are fired up with the idea of a "June crisis."

**Suzuki and Tsuchimitsu Conflict Expected?**

Let us analyze Fukuda's argument. He says that "the problem cannot be handled with small tricks" and "there are only three possible countermeasures--a cut in expenditures, increased issue of deficit-covering bonds, and a tax increase." He emphasizes that Zenko Suzuki is holding tight to the banner of "getting away from a system of dependence on deficit-covering national bonds by 1984." Fukuda concludes: "Construction bonds and deficit-covering bonds are both debts. If more and more national construction bonds were issued, the issue of deficit-covering bonds could be reduced to zero by 1984. However, this is sophistry and window dressing." When it comes to a tax increase, in other words, the introduction of a large indirect tax, he makes the point that "Suzuki has said that he will not do it." Suzuki's predecessor, Masayoshi Ohira, introduced a large consumer tax in 1979 just before the LDP presidential election and was overwhelmingly defeated. Fukuda's statement is based on the supposition that Suzuki observed this "nightmare" from the sidelines and there is no chance that he would make use of a large indirect tax.

However, as Suzuki advances along this path there is a trap waiting for him. It is easy to talk about a "drastic reduction" in expenditures, but it is not easy to carry out in reality. The leading members of the Fukuda faction say: "It is false to say that it will be easier to reduce expenditures now that the revenue shortfall has grown so large. There are many complainers in the party and it will be impossible to repress them. The local government offices will not keep quiet." And if only small reductions are made, it will not escape the sharp glance of Toshio Tsuchimitsu, chairman of the temporary administration study committee and the emperor of administrative reform. Ultimately, they are expecting an "inevitable clash between Suzuki and Tsuchimitsu." The boss of the faction, Fukuda, is certainly aware of these views. Fukuda's orders are made in anticipation of the idea that "a large scale reduction of expenditures cannot be made by Suzuki."

**A Revenue Shortfall of 3 Trillion Yen Also Occurred in the Past**

Zenko Suzuki is also taking a tough approach. "I am partly to blame. However, we are in difficult circumstances and no one has any good ideas. Doesn't

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anyone have any good ideas? Be that as it may, there has been a 3 trillion yen revenue shortfall before." He remains unperturbed: "Even if there is a shortfall of 2 trillion yen in 1981, 1982 is still a year away. Mr Fukuda has a lot to say, but he has not said what should be done at all."

One reason for Zenko Suzuki's "confidence" is that, as he points out, there has been a "3 trillion yen," even a 3.8 trillion yen, revenue shortfall in the past. The 3.8 trillion yen shortfall occurred during the period of the Miki cabinet and the 3 trillion yen shortfall referred to by Suzuki occurred under the Fukuda cabinet. Mr Komoto who was responsible for finances under the Miki cabinet takes a cautious posture. "Tax revenues cannot be guessed to the penny. During the first oil shock there was a shortage of 3.8 trillion yen. Some things cannot be helped."

However, Fukuda proudly asserts: "When it happened to me, it was during the oil shock and a period of great economic changes so the people understood." He takes the position that those circumstances were different from the present ones. An official in the prime minister's office interprets his position as follows. "Fukuda is saying that Mr Suzuki cannot make excuses because he made a public commitment to financial rebuilding. It was all right for Mr Fukuda because he did not make such a commitment."

One economic commentator wryly says: "Fukuda was known as the economic prime minister in the Miki cabinet so he was responsible. Also the system of dependence on national bonds was started by the minister of finance in the Sato cabinet, Mr Fukuda. The fact that he seems to have forgotten such things shows that Fukuda is also rather brash."

Fukuda has used tactics which take advantage of an anticipated failure on the issue of national electoral district reform as well as the issue of the revenue shortfall. The "hidden Shogun of Meiji," Kakuei Tanaka, issued a directive to begin working on this issue. But when Tanaka's influence began to decline, Fukuda began to shout, "National electoral district reform is absolutely necessary!" At the beginning of April, he went into the office of the chief cabinet secretary in the Diet building and told Susumu Nikaido, "I want national electoral district reform to be passed no matter what." Sources close to Suzuki, with a view to the little remaining time in the Diet session, say "Fukuda is saying 'Do it!' because he knows that it cannot be passed." If it is not done, this also will become a "violation of a public commitment" for Suzuki. Fukuda has begun saying, "I will do it. I will do it." Ironically, since Fukuda began making these statements, Tanaka faction leaders such as Noboru Takeshita, deputy chief cabinet secretary, and Masakiyo Gotoda, election study committee chairman, have begun actively working behind the scenes.

Mr Fukuda a Champion of Justice?

Mr Fukuda's distrust and dissatisfaction is really not directed at Zenko Suzuki but at the man who stands behind him, his rival, Kakuei Tanaka. In the cabinet reshuffle and personnel changes in party leadership last November, Zenko Suzuki abandoned the balance which had been maintained between the

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Tanaka and Fukuda factions and moved sharply toward the Tanaka faction. After that, Fukuda raised a clenched fist and vowed to "overthrow the Tanaka government." He clearly shouted "Tanaka government," not "Suzuki government."

His fear and distrust of Tanaka are very strong. Recently, a group of reporters asked him, "'Kaku-san' has begun talking about constitutional reform. What do you think this means?" He replied irritably, "Why has Tanaka started talking about that now? He did not in the past. I do not know." His feelings were apparent in the fact that he called Mr Tanaka "Tanaka" instead of the usual "Kaku-san." This year's politics will be dominated by the "fifth Tanaka-Fukuda war," following the original Tanaka-Fukuda war, the removal of Fukuda from the Tanaka cabinet, the Ohira-Fukuda war, and the 40-day war. For Fukuda, who always wants to take the position of a champion of justice, it is easy to take a position against this opponent. The subject of the Lockheed trial is taboo inside the LDP. However, Fukuda has frankly stated: "If Tanaka is convicted before the lower house elections next summer, it will be the end of the LDP. If there is a double election, it will mean total destruction." In a sense, Fukuda is paying more attention to the Lockheed first trial decision on Tomisaburo Hashimoto and Takayuki Sato on 8 June than to the revenue shortfall. Leading Fukuda-faction Diet members predict that "if Tomi Hashimoto is convicted, it will create shock waves in the political world." And they also state emphatically that "if the name of Nikaido comes up in the Lockheed decision, it will involve the responsibility of Prime Minister Suzuki who used him as chief party secretary."

Through the intercession of Mitsuo Setoyama, Fukuda had a "5-minute meeting" with Tanaka on 23 October last year. Setoyama made this move in order to promote Fukuda in the event that Zenko Suzuki failed midway through his term. Fukuda naturally understood this. Subsequently, Fukuda was told that "Tanaka will never support Fukuda. Fukuda himself should know the reason for this." After that, it is reported that Fukuda's fighting spirit suddenly blazed up.

So then, what sort of tactics will Fukuda use in the "fifth Tanaka-Fukuda war?" The best he could hope for would be an early retirement by Zenko Suzuki and the emergence of an "interim Fukuda government" through negotiation. Fukuda himself could not take the role of removing Suzuki. After being beaten out by Takeo Miki when Tanaka resigned in 1974 through "Shiina's arbitration," Fukuda is well aware of this. He must wait for Zenko Suzuki to wound himself through the revenue shortfall or wait for someone else to pull the trigger. The "removal of Komoto" may be one effective means of pulling the trigger. However, observers close to Komoto say that "Komoto feels that he is partly responsible for the revenue shortfall, so he will probably not resign." If that is the case, it is hard to imagine Suzuki "committing suicide." There is very little possibility of this happening.

Another possibility is for Fukuda to be elected through negotiation because of confusion in the election for party president. Fukuda has said, "The supreme advisory council should play a coordinating role in selection of the president. In such a case, the oldest advisor, Mr Kishi, should do the coordinating." He is planning that he would be selected by his mentor, Nobusuke Kishi.



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However, there is little likelihood of this happening in reality. It is doubtful that much authority will be given to the supreme advisory council. If that is the case, the election for party president will be a contest of power. Then the situation will vary decisively depending on whether there are three or four candidates. If there are four candidates, a public election will be held among the general party membership. If there are three, such an election will not be held. Fukuda has said, "If a public election is held, Komoto will get half the votes." The "young officers" of the Fukuda faction such as Mutsuki Kato are conspiring. "There is no other way to win than to get four candidates and hold a public election where Komoto will come out on top." However, while Suzuki and Komoto might emerge immediately as candidates, it is possible that Administrative Management Agency Director General Yashuhiro Nakasone could stay out of the race and back Suzuki. Then there would be no third or fourth candidate. There are some who would support Kazuro Tamaoki of Shuseiken on the premise that it should be "someone who will not be a future candidate for party president." Even so, there would still be no fourth candidate. Science and Technology Agency Director General Ichiro Nakagawa enthusiastically says, "If neither Abe nor Takeshita run, I might borrow some of their people and run." But this would bring a cry of "Hold on!" from the Fukuda faction. A leader of the Fukuda faction says, "If Nakagawa became a candidate for party president, it could mean a reversal of position between him and Abe who is in the position of an 'elder brother' to him."

Almost no one believes that Fukuda himself has abandoned the dream of an interim government. Even if he had, it is a fact that "he has not definitely decided to support Komoto."

If Komoto does not have support, there is the possibility of bringing up a "new leader."

It is reported that Fukuda's close associates asked him, "Nakagawa is straining at the bit. How about having Abe run?" and Fukuda's reply was, "Who is this Abe?" Both Fukuda and Tanaka feel that "a 'new leader' would be someone of colonel or lieutenant colonel rank." The common feeling of both men is that "if one of them became commanding officer, it would mean a change of generations. That is what we fear most." Shin Kanemaru declares "You can talk about changing the pitcher, but there is no one to substitute."

There are also some outsiders hoping for a split like Ikko Kasuga of the Democratic Socialist Party who says: "Four candidates must be fielded one way or another. If there is trouble in the final contest, it will give strength to the Fukuda-Komoto-Nakagawa-Democratic Socialist line." However, ultimately Fukuda will have difficulty recruiting enough people.

Fukuda now says: "There is half a year left. It is from now on that the heavens will move." For the sake of this aging "golden bat" we should pray that events do not turn out as they did after the Ohira-Fukuda war when he said, "the voice of heaven sometimes says strange things."

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**ECONOMIC**

**STAGNATION OF ASIAN ECONOMY DEEPENS**

Tokyo NIHON KEIZAI SHIMBUN in Japanese 28, 29 May 82

[28 May 92 p 5]

[Text] Conditions have recently become poor for the economies of a number of Asian countries which had, up to now, achieved relatively uniform growth. With the prolongation of the recession in the advanced countries of Europe and America, in addition to the collapse into stagnation of the exports of the NICS (newly industrialized countries), the Southeast Asian region, including the oil producing countries, cannot escape a slowing of growth due to the decline in prices for primary products, under the influence of the surplus supply of crude oil. We have summarized the present state and prospects of the Asian economies based on reports from special correspondents on-the-spot.

South Korea, which had taken the lead in economic development among the NICS, is at present very uncomfortable. In 1980, the real GNP (gross national product) experienced 6.2 percent negative growth due to the effects of the second oil shock, but in 1981 achieved 7.1 percent growth, and the government expected 7 percent growth again this year. However, entering 1982 the South Korean economy again displayed stagnation and for the first quarter (January-March) the GNP was held to a 4.2 percent growth rate. Even though recovery is expected in subsequent periods, 1982 will be limited to, at most, the 5 percent level. The fifth 5-Year Plan (1982-1986) put forth last year by the Chun Do Hwan government is already on the point of being revised. The government plans to extend the time frame of enterprises involving heavy investment and reduce the amount of borrowing from foreign countries. This is because with the stagnation of exports and domestic demand intended capital expenditures in the private sector are also reduced.

Taiwan expected that the 5.5 percent growth of 1981 would be followed by a jump to 8 percent annually for the period 1982-1985. However, according to predictions made by the Bank of America, growth will remain at 5.5 percent for 1982 and become 6.5 percent in 1983. There are those among Taipei economists who think that this year will see a growth rate lower than last year.

Even in Singapore, which had sustained smooth development despite the second oil shock, the 7.2 percent rate of growth of the GDP (gross domestic product) in the first quarter was the lowest quarterly growth rate recorded in the last 4 years. There is also no sign of an end to inflation, and the rate of

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increase in the price of consumer goods of 8.3 percent in 1981 was followed by an even higher 9.2 percent for January-March of this year. For Hong Kong also, the 10.4 percent growth (real GDP) of 1981 was followed by more restricted circumstances, with a probable 8 percent increase this year.

**The Recession in the Advanced Countries is Painful**

Why are the NICS, which had showed themselves the most able students among the developing countries, in recession at present? The most immediate cause is the stagnation of exports due to the world wide recession centered on Europe and America. Exports have come to be the engine of growth for the NICS, which have small internal markets. In the case of Taiwan, they amount to a powerful 50 percent of the GNP, and in South Korea they comprise 35 percent.

However, beginning this year, NICS exports uniformly showed distressing rates of growth. In South Korea, the total for January-March was held to a slight growth of the level of 5 percent compared to the same period of last year. Given that South Korean exports had increased annually in the range of 15-30 percent over the last 5 years, the fall off is striking. Moreover, it is expected that for May a minus 0.2 percent will be recorded. For Hong Kong also, the 29 percent increase of 1980 was followed by 24 percent in 1981 but dwindled to a 10 percent rate of increase for January-March 1982.

On top of the recession in the advanced countries, the beginning of restraint on imports by the Middle Eastern oil producing countries, which had been a large, growing market, has a considerable influence. For this reason, even South Korea, which has earned foreign exchange by rapidly expanding the export of construction services to the Middle East, has been working in recent years to diversify the destinations of its exports in Southeast Asia and Africa. Even so, structural factors allow no hope of an early significant improvement in the stagnation of NICS exports.

**Effects Extending to Earnings Leader Textiles**

The NICS, which have achieved their desired economic development, have also experienced in the last few years a rapid increase in wages and their competitiveness in the export of labor intensive products has rapidly fallen. There is a report on "The present state of the international competitiveness of South Korean manufacturers as seen by the buyers," prepared in April by the South Korean Chamber of Commerce. In 1979, 65 percent of those planning the purchase of South Korean manufacturers considered them "less expensive," but this year the number fell to 54 percent.

Among the buyers those who responded "we are switching our source of imports to another country" increased from 10.7 percent last year to 15.2 percent this year. As beneficiaries of switching, Taiwan was most common, followed by Hong Kong and China successively.

There is no cause for complacency in Taiwan or Hong Kong. Textile exports have been the flag bearer for NICS' development, but their decline in the last year or two has been spectacular. For Taiwan, 1981 textile exports surpassed a 15 percent gain and cracked the 20 percent level, but this year there are

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restrictions on imports under the new MFA (Multinational Fabrics Agreement) and they will evidently decrease about 5 percent.

For Hong Kong also, orders on hand for textile products, its largest export, declined for 3 months in succession through February. The group of industries comprising spinning, weaving, and dyeing can no longer pay their way under pressure from the underdeveloped countries of Asia. Apparel makers must import their raw materials from places where land is cheaper, and their competitive advantage with respect to delivery dates is decreasing.

**The Raising of Productivity is not Progressing**

On the other hand, the movement to try to increase productivity through a shift to technology intensive production is not progressing as hoped. Prime Minister Lee Kuan Yew of Singapore has been calling in recent years for a 'second industrial revolution' involving enhancing the technology intensiveness of production and improving productivity. In order to make the wages of workers appropriate for this they have been increased by about 20 percent each year for the last 3 years under government leadership. However, basic productivity has not increased as expected. Tony Tan, Singapore's minister of trade and industry, had said, "From January through March productivity has increased no more than 1 percent. Hereafter it will be necessary to hold the rate of wage increases to the scale of the increases in productivity," so there has begun a change to a policy of restraining wage increases. Over the last 10 years wages have increased between 31 and 39 percent, after discounting inflation, and this has engendered a satisfied mood currently among the workers. The government is presently trying hard to figure out a way of motivating the workers.

South Korea vigorously promoted in the second half of the 1970's a revolution in science-intensive industry and this was a major factor in the recent expansion of exports. However, even the greatly favored export of shipping has become insecure as there is the prospect of a decrease for April, on the basis of letters of credit in hand, of about 0.7 percent compared to the same period of last year. Overall, science-intensive products are down 13 percent.

According to a study prepared by the South Korean Government at the end of last year, the result was that for color televisions, steel products, passenger cars, and others, fob prices were uniformly lowered and export carried out at a loss. Even for South Korea, which among the NICS is farthest along in changing to high technology industry, conditions are poor.

The NICS have come to a major plateau in economic development. And, the world recession is aggravating their discomfort. Even if they do raise productivity, when the overseas markets are weak they cannot increase the rate of factory operations. Japan, first, but the advanced countries of Europe and America also will fight desperately to avoid being overtaken in the area of technology intensive industry. As the ferocious struggle between the developing and the advanced countries intensifies in a world economy that resembles a zero-sum game, there seems no chance of bright prospects opening up in the short term.

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[29 May 82 p 5]

[Text] "In order to weather the present world recession, the most urgent problem is to tighten our belts." So Malaysian Prime Minister Mahathir, taking no time to enjoy his landslide victory in the elections at the end of May, launched an appeal to rebuild that country's economy. Malaysia, which exports valuable primary products including excellent quality oil and has progressed in industrial development, last year for the first time in 20 years became a trade deficit nation and is being obliged to modify the fourth 5-Year Plan begun last year. The Malaysian economy, which had in recent years maintained close to double digit growth while avoiding any slowing in the rising value of its products and which has won the prize as the "star pupil of ASEAN (Association of South East Asian Nations)," has "exposed its softness (FAR EASTERN ECONOMIC REVIEW)."

**Substantial Decline Everywhere**

The most important factor causing the Malaysian economy to stumble is the anticipated fall in the prices of primary products. Primary product prices, which held relatively firm in 1979 and 1980, continuously declined in 1981 under the influence of the prolonged recession in the advanced countries of Europe and America, and prices have fallen significantly.

For example, in terms of prices as exported from Kuala Lumpur, the 1981 average price of natural rubber was down 15 percent compared to the previous year, of tin down 12 percent, and of palm oil down 5 percent. Petroleum was on a yearly average basis higher than the previous year, but at the end of the year it declined substantially.

In sum, Malaysian exports of agricultural primary products for last year were down in total value 10 percent compared to the previous year, and exports of mining products, including oil, were down 1.7 percent. In addition the export of electronics and other manufactured goods was also greatly lower, by 17.3 percent, and the total value of exports was 5.6 billion Malaysian dollars (about 10 billion U.S. dollars), 10 percent lower than the previous year.

At present the trade deficit is still small but as the flow of imports remains at its former high level the outflow of capital is severe. Because of this the reserves of foreign exchange at the end of March at \$3.4 billion were about \$600 million less than at the end of last year, and this gives the government much concern.

The fact that the worsening of economic conditions due to the recession in the advanced countries has even extended to oil producing nations is a characteristic of the recent East Asian economy. OPEC member Indonesia is no exception. Among the decisions made at the OPEC general meeting in Quito this May Indonesia determined to continue holding down production and will fall short of its targeted income from oil by some \$3 billion annually.

And, as with Malaysia, exports of coffee, rubber, and other agricultural products are depressed. The end result is that the expenditure boom, once

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backed by ever increasing oil revenues, is beginning to exhaust itself. Going into this year the production of textiles, automobiles, and other Japan-related enterprises had fallen to 20-30 percent less than the comparable period of last year, and outcries have arisen that this is the "contraction following expansion."

Among the non-oil producing ASEAN countries, the economy of the Philippines, which had felt the most severe consequences of the oil shock, has, without being given a chance to start to recover, been even further depressed. As for the value of Philippine exports of primary products for last year, sugar was down 5.9 percent, lumber 15.6 percent, copper 19.9 percent, and nickel 35.6 percent compared to the previous year, and there is no sign of recovery so far this year.

With the fact that the manufacturing sector has also not grown this year as much as expected, the trade deficit for the first quarter of this year was more than double that of the same period last year (\$312 million) at \$639 million.

Prime Minister Virata recently announced that "the rate of growth of the real GNP for 1981 was 3.8 percent in terms of fixed values." This is one point lower than the 4.8 percent provisionally reported, and is the lowest rate since 1973. The Philippine economy seems compelled at present to follow a downward curve.

**Thailand Also Proclaims "Recession"**

In contrast, Thailand, also a non-oil producing developing country but one with a primary export of rice, was lightly affected by the downward trend of prices in 1981 and, according to government announcements, the rate of growth of the real GDP was 7.6 percent better than predicted. At worst, lately, auto sales, which were expected to be good, declined, and textiles were forced to cut back operations, which did give a disquieting complexion to the lavishly celebrated bicentennial of the Chakri Dynasty in April.

Finance Minister Sommai at a press conference on the 11th following the cabinet meeting to determine the budget for the 1983 fiscal year (October 1982-September 1983) issued a "declaration of recession," saying, "Hereafter, government expenditures must be substantially restricted due to the deterioration of conditions."

The ASEAN countries, excepting Singapore, are alike in depending fundamentally on the export of primary products, but here, too, industrialization has made progress recently and the proportion of manufactured goods among their exports has increased. The prolonged recession in the advanced countries has hit these nations with a double blow of declining prices for primary products and stagnation in the export of manufactured products.

As a result, the ASEAN countries, which had maintained real growth through the second half of the 1970's and 1980 that approached double figures and was never less than 5 percent are also compelled to slow down to some 2-3 percent for this year and next.

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However, if we compare them to the NICS, their dependence on exports is less so that the effects should be less. Malaysia, with the highest percentage of exports in the GDP at 38.2 percent is the hardest hit, and the good showing of Thailand, where this percentage is only 20 percent, also illustrates the point.

Propping Up Construction, Etc.

Amidst anticipation of a recovery in the United States in the second half of the year, it goes without saying that these primary product nations along with the NICS are hoping that "American recovery will be early and strong." The view is frequently expressed in Malaysia and elsewhere that "If we seek the root of the present recession it is the high interest rates in the United States and the strength of the dollar, and if the recovery of the European and American economies is not far off we should see a clear period." The optimistic thesis is deeply rooted that when conditions in the advanced countries improve double digit growth will again be possible.

However, it is undeniable that there will be a time lag of "about half a year (Malaysian Central Bank)" in recovery in Europe and America bringing about increased demand and higher prices for Asian primary products and restoring life to the Asian economy. The Philippines recently established a policy of stimulating demand in the farming villages by raising the price at which the government purchases hulled rice and lowering the price of fertilizer, and other Asian countries are also planning to prop up areas where the boom to some extent continues such as construction, seeming to be just waiting for European and American recovery.

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**ECONOMIC**

**ASPECTS OF JAPANESE YEN STUDIED**

**Yen Exchange Rate Speculations**

Tokyo SHUKAN TOYO KEIZAI in Japanese 1 May 82 pp 16-19

[Text] Last week, the yen exchange rate underwent a rebound following a period of weakness. On April 23, it closed at 243.10 yen, and a brake to the yen's slide seems likely. At the turn of this year, a high yen in the first half and a weak yen in the second was predicted, but the actual situation was just the opposite.

There are two reasons for the unexpected yen's weakness. First, due to high U.S. interest rates, the interest rate differentials at home and abroad did not decline, and the outflow of long-term investments continued, leading to a shortage of dollars.

Second, with gloomy prospects of the yen exchange rate, contracts for future imports (purchase of futures in dollars) accumulated, applying pressure on the commodity rate. Estimates are that contracts for future imports outstanding at the end of March exceed the contracts for future exports (future sales in dollars) by 3 billion yen.

The accumulation of contracts for future imports represents the upfront nature of dollar requirements. Thus, it works as a factor for a weak yen at that time, but at a subsequent time, it leads to a drop in dollar demands and a strong yen.

The cumulative amount of contracts for future imports has a plus effect on the yen exchange rate as it acts as a factor for a strong yen. In short, there are mounting signs that the weak yen material from January to mid-April will show a reverse effect hereon.

Incidentally, the yen exchange rate, among major currencies, is known for its wide range of fluctuation. It is like "high peaks with deep valleys." What is the reason for the overshooting?

**Why the Yen Exchange Rate Fluctuates So Widely?**

Normally, there are three determining economic factors in the yen exchange rate: (1) balance of payments, (2) wholesale commodity prices, and (3)



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interest rates. The first and second are termed fundamentals. Up until now, the yen exchange rate has been discussed mostly around the fundamentals.

An extension of the views on the exchange rate indicates that such views are linked to the theory that the weak yen, until recently, has been a "reflection of weakening fundamentals in Japan's economy." It cannot be denied that the current "theory on Japan's economic deterioration" is firmly linked to the keynote of a weak yen.

However, the yen exchange rate does not move on fundamentals alone. A major factor is the interest rate differentials, home and abroad. Especially, after December 1980, exchange transactions were generally liberalized under the new Foreign Exchange Law. As a result, it became possible to apply long-term funds kept in this country to other countries, taking advantage of interest rate differentials. This is the point that has been overlooked.

According to the "savings propensity survey" (1981) by the Prime Minister's Office, personal savings (worker's households) amounted to 115 percent of annual income. In other words, total personal savings exceeded annual income by 15 percent. In 1980, it was 105.4 percent. The diversified foreign application of such savings deposited with financial institutions is natural, of course.

**Real Interest Rate Differentials Scrutinized**

In the Ministry of International Trade and Industry's "1981 Production Trend in the Mining Industry," an analysis into factors for changes over the previous quarter looks at the weight of Japanese-U.S. real interest rate differentials with utmost concern. This is followed by Japanese-U.S. balance of payment differentials (seasonally adjusted value) and thirdly, the fluctuation in Japan's foreign currency reserves over the previous quarter.

The analysis covers the period from January-March quarter of 1975 to the July-September quarter of 1981. But with the enforcement of the new foreign exchange law from December 1980, the actual view is that the Japanese-U.S. real interest rate differentials would weight more heavily than indicated in the analysis.

A greater importance is placed on the real interest rate differentials than on the nominal for the following reason: If the escalation of nominal interest rates in the United States is a reflection of rising inflation, the interest rate rise is an unavoidable one in the midst of the worsening fundamentals. Hence, there would be no great outflow of funds from Japan.

However, since 1981, high U.S. interest rates have persisted, notwithstanding lower wholesale commodity prices. For instance, while the federal fund rate remained in two-digit figures, the real interest rate was 4.6 percent, 8.5, 14.9 and 14.1 in the first, second third and fourth quarters of 1981 respectively, and 10.4 percent in the January-February period this year.

**Outflow of Long-Term Investments**

In such a way, U.S. real interest rates began to escalate. But with Japan lowering its interest rates, the Japanese-U.S. real interest rate differentials

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reflected a minus position from April-June 1979 to April-June 1980. By minus is meant that the U.S. real interest rates were higher than Japan's. The real interest rate differentials again showed a minus from April-June 1981 to January-February this year.

Again refer to the chart and note the movement of the yen exchange rate (primary exchange rate during term) and the Japanese-U.S. real interest rate differentials. An examination of the period after 1979 where the Japanese-U.S. real interest rate differentials shows a minus reveals that the yen exchange rate is under the 200 yen range. In other words, it runs between 220-240 yen. An exception is during the April-June quarter of 1979 when it was 218.43 yen.

It can be observed that while a close relationship exists between Japanese-U.S. real interest rate differentials and the yen exchange rate, Japan's exchange rate policy was no policy at all. It seems that the argument "Japan's interest rates ought to be lowered in line with the U.S.'s" was unduly emphasized.

Another point is that some industries are still unfamiliar with the floating exchange system. In the oil industry, for instance, there is a lack of awareness about changes in the exchange rate and the creed there is that a "strong yen is normal." Such a creed ultimately led to a great shakeup in the yen exchange rate.

**What Lack of Exchange Policy Led To**

Those sensitive to the interest rate differentials, at home and abroad, are institutional investors such as life insurance and trust companies. To institutional investors who compete for interests on their assets, the world is the scene for application of funds.

Recently accused of being the "chief reason for a weak yen," institutional investors have cited the following as grounds for application of their funds overseas:

First, from the standpoint of diversification, investments need to be spread out for reasons of safety. Second, while domestic application of funds is desirable and without exchange risks, the slack demand has made overseas application necessary.

At one glance, the first and second reasons appears to be inconsistent. The former can be regarded as a structural reason and the latter a cyclical reason. From such a point of view, any diminution of domestic and foreign interest rate differentials should apply a brake to fund application overseas based on the cyclical reason.

**Operating Stance of Life Insurance and Trust Companies**

Delicate changes have been noted between life insurance companies and trust companies in the manner of application of foreign loans. In the application of funds, they would watch both foreign interest rates (bond market) and the exchange (yen exchange rate). The life insurance companies, however,

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would not have to be overly nervous since, for example, a capital loss owing to exchange rate fluctuations can be treated as an integral process of application of total assets.

In the case of trust companies, because they involve the use of annuity funds, working profits or losses must be handled as annuity accounts. Separate from the trust account, the annuity account must bear any losses in the use of the annuity fund. Since interest received by the annuity fund would decrease to that extent, utmost caution is required.

In the application of funds overseas, a certain trust bank has followed the "4 percent rule" as a standard. A short-term application, it would be applied when the interest rate differentials between the Euroyen and Euro currency opens up 4 percent or above. This 4 percent rule would "ensure 80 percent success in application" (certain trust company). An 80 percent assured rate is considerable.

What is the policy of institutional investors with respect to application of funds overseas hereafter? They can aim at capital gains on bonds when the yen is strong as U.S. interest rates would then be moving downward. But as a strong yen means a weak dollar, there would be rope-pulling between the amount of this weakened dollar and capital gains.

For institutional investors, the most ideal time would be when U.S. interest rates fall drastically. But the advantages will vanish as time passes. That is because the bond market embraces the decline in the interest rates. Over the long-term, the outflow of long-term investments from Japan should gradually ease up through the diminution of Japanese-U.S. real interest rate differentials.

**Oil Companies' Deep Faith in Strong Yen**

As opposed to institutional investors sensitive to domestic and foreign interest rate differentials, the oil industry can be classified as a case of failure owing to overconfidence in a strong yen. A tabulation of the oil industry's profits and losses from exchange rate differentials from fiscal 1972 to 1980 shows a profit of 1,288,300 million yen and a loss of 507,600 million yen (refer to this journal of March 13, 1982), leaving a profit of 780,800 million yen.

This would invariably make one wish to wait for a kamikaze (strong yen), but exchange policies have completely fallen behind. The ratio of crude oil and low-grade oil to the amount of imports cleared through customs in fiscal 1981 was 37.1 percent, worth some 52,900 million dollars, or a monthly average of 4,400 million dollars. Carrying such a weight, whether the oil industry will issue contracts for future imports smoothly will have a large impact on the supply and demand for dollars in the exchange market.

The oil industry's contracts for future imports cover a very small amount, less than 10 percent of the value of oil imports. Compared to about 30 percent for other industries, the amount is minimal. But in view of the continued financial distress, it is understandable that the oil industry

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wants to avoid a situation of cost and loss confirmation through early issuance of contracts for future imports.

However, it is choking its own neck, for it brought about "mixed errors" which became associated with a weak yen. All of Japan would stand to benefit if the oil industry realizes the failures of its exchange policy and acts to stabilize the yen exchange rate through a gradual increase of contracts for future imports.

Yet, for contracts for future exports and for future imports to accumulate unilaterally would be undesirable. If there is a balance, it should not be a factor for disruption of the exchange rate. For a major importer like the oil industry to constantly shy away from contracts for future imports is not praiseworthy.

**Around 220 Yen in April-June Quarter**

Several points of misunderstanding hover over Japan's exchange market: the thoughtless promotion of low interest rates in disregard of Japanese-U.S. real interest rate differentials, and reluctance to issue contracts for future imports. Among the major currencies, the yen exchange rate undergoes the largest fluctuation.

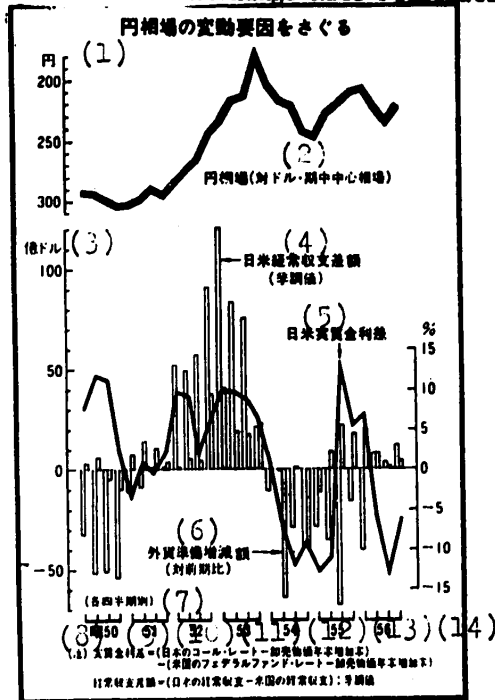
The yen exchange rate can be expected to stabilize gradually if these points are recognized and corrected. But even if intermediate and long-term stability were to be achieved, the crux is whether the fabric of last week's yen rebound will be sustained.

In the chart, a pattern can be noted in the trend of the yen exchange rate, Up until 1978-1981, the primary exchange rate during April-June closed at about 220 yen. Even during a change from a strong yen to a weak yen or vice versa, the 220 yen level of April-June was observed in each year.

Why it remains around 220 yen during the April-June quarter is unknown. It may be that this level is "comfortable" (appropriate) for the yen exchange rate. One exchange dealer (a leading exchange bank) says "around 220 yen is possible in the April-June quarter this year."

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## Factors for Yen Exchange Rate Fluctuation



## Key:

- |  |          |
|--|----------|
| 1. Yen   | 8. 1975  |
| 2. Yen exchange rate (primary rate against dollar during period)                 | 9. 1976  |
| 3. In 100,000 dollars  | 10. 1977 |
| 4. Japanese-U.S. current transaction differential (seasonally adjusted values)   | 11. 1978 |
| 5. Japanese-U.S. real interest rate differential                                 | 12. 1979 |
| 6. Foreign currency reserves, increase or decrease (compared to previous period) | 13. 1980 |
| 7. (By quarters)   | 14. 1981 |

N.B. Real interest rate differential= (Japan's call rate - rate of yearly increase of wholesale commodity prices) - (U.S. federal fund rate - rate of yearly increase of wholesale commodity prices)

Current transactions differentials= (Japan's current transactions - U.S. current assignments); seasonally adjusted values

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**Liberalization of Yen**

Tokyo SHUKAN TOYO KEIZAI in Japanese 1 May 82 pp 20-23

**[Text] Resolution by Stronger Intervention**

Similar to economic management distressed at having to cross a tightrope, the formulation of countermeasures against the weak yen is pressured under numerous impediments.

On the point of blaming the U.S.' high interest rate policy for the "abnormal" phenomenon of a strong dollar, Japan and the EEC nations are in agreement. But when it comes to the matter of a weak yen, the EEC nations are hard on Japan. The leaders of EEC nations have frequently charged Japan with "following a policy to induce a weak yen" and do not lend an ear to Japan's rebuttal of "biased thinking based on misunderstanding."

As logic, that may be true. But unfortunately, Japan's policy makers' true intent may be that to have a realistic policy, reverse measures are needed. This is because they come under the yoke of unclear economic prospects, increased trade friction and financial revitalization.

As a result, some even claim that until there is improvement in the level of U.S. interest rates, nothing can be done except to step up yen buying and dollar selling activities. But it does not appear that a reduction of U.S. deficits or budget revision will occur in May, and there is no time to waste, simply relying on the United States. Further, strong policy measures for a strong yen are needed prior to the summit. Also, should a weak yen continue over a long-term, there could be concern over the emergence of import inflationary symptoms caused by price hikes of imports.

In view of such conditions, there is little time to confront the issue of a weak yen. It seems that the Bank of Japan intervened in March with over 1 billion dollars and again in the first 10 days of April with under 1 billion dollars. It has been intervening increasingly to prevent the yen from rising above the level of 250 yen to 1 dollar.

**Opportunity For Making Doubly Sure Thru Emergency Restrictions**

Whether intervention alone can prevent the yen from rising above 250 yen and renewing the weak level or move downward to the 230 yen level does not rule out skepticism. Also, the Ministry of Finance is apprehensive over a drop in foreign currency reserves for 4 consecutive months, and there is no definite assurance that "stirring intervention" would continue.

Slightly prior to March 31, the day the yen fell once again to the low level of 248 yen and renewing this year's low, a proposal had been made on short notice to invoke "emergency restriction" measures based on the Foreign Exchange Law. The Ministry of Finance's International Finance Bureau Chief Kato had hinted at its possible invocation in the Diet, and even Bank of Japan President Maekawa who previously had opposed the emergency restrictions changed his mind and concurred.

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Through greater intervention coupled with anticipated action, the yen exchange rate steadily rose, and around last week, observations were growing that "emergency restrictions may not have to be invoked."

It is common knowledge that a false statement is permissible up to the last minute in the case of invocation of emergency restrictions as is with yen revaluation. From the nature of emergency restrictions, the most effective method is to strike hard at the other party and persist when the exchange rate is about to change. In that sense, this may be a good time.

**When To Draw the Heirloom Sword**

The emergency provisions, aimed at supporting the yen against the foreign rate, provides for several methods. First is the "non-standard loan system" created by the Bank of Japan at the time of 1-percent cut in the official rate in March last year. This is a measure designed to pad the Bank of Japan's loan rate to financial institutions above the conventional official rate in an emergency situation of excessive outflow of short-term investment due to wider domestic and foreign interest rate differentials or a weaker yen. Though the term runs 3 months at most, a much shorter term is desired. The targets are all financial institutions having contracts for loans on notes with the Bank of Japan (largest effect on city banks).

If one of the major reasons for the currently weak yen lies in the Japanese-U.S. interest rate differentials, nonstandard loans can be termed as appropriate. Interest rates can be adjusted with interest rates. However, the Bank of Japan does not have "confidence" that the non-standards' invocation will prove effective because the weight of outflow of long-term investments is a vital factor in the yen's weakness and there are signs of anxiety abroad over Japan's economic situation.

If the intent is to bury Japanese-U.S. real interest rate differentials, non-standard interest rate amounting to about 3 percent can be added. But in this case, there will be violent reaction from Japan's exponents of economic priority. A mere 0.5 percent or 1 percent may be too little to expect results, and the timing for lifting emergency measures would be difficult to grasp. At any rate, a dilemma would occur.

At the moment, the feeling is that there is no choice but to continue with intervention through "Operation M." (Initial of President Maekawa; used in Western circles to mean Bank of Japan's weak yen measures).

Nevertheless, a step similar to the non-standard loan is now being followed. It is a measure being pushed vigorously since the latter part of March in order to realize high, short-term money market interest rates. To absorb the surplus funds of commercial banks, a great quantity of bargain notes were issued. As a result, the call rate climbed to the range of 7 percent and reverted back to the high level that prevailed before the official rate was lowered in December last year. Further, on four occasions since April 9, TB (government short-term securities) worth an aggregate 2,400 billion yen

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were sold. Another sale is scheduled soon, amounting to about several hundreds billion yen.

A measure which calls for high, short-term interest rates in a time of low, long-term interest rates (0.2 percent reduction for long-term bonds and others from April) is unprecedented.

The Bank of Japan's strategy appears to be to reduce domestic and foreign interest rate differentials through such means, monitor the movement of short-term investments and the yen exchange rate, and if this does not work out, to resort for the first time to the "heirloom sword."

**Difficult Decisionmaking Environment In Spite of Emergency**

If the non-standard loan system is the means to counter a weak yen from an interest rate aspect, the emergency restrictions under the Foreign Exchange Law does so from the quantity aspect. Further, the emergency restrictions are more stringent than non-standard measures.

With the enforcement of the new Foreign Exchange Law in December 1980, Japan's exchange and trade policies took a major shift toward "general liberalization." But excepted conditions under emergency restrictions were legally prescribed for invisible trade and export-import transactions. Extending to 22 pages and concentrating on capital transactions, the material covered the scope of restrictions and numerous methods.

Free capital transactions in normal times can be changed into a permit system in an emergency, while the pre-notification system of transactions can be changed or terminated upon advisement. To effect compliance, the Minister of Finance is empowered to issue "orders."

As abnormal conditions, there are seven, to include: (1) a balanced international balance of payments running into difficulty; (2) sudden changes in the yen's foreign exchange rate; (3) a great shift of funds, domestically and externally, adversely affecting Japan's financial and capital markets.

In view of the above, the invocation of emergency restrictions will not be unusual under the present situation of "sniping at the yen."

**Outflow Restrictions on Small Sums**

Though not an invocation of emergency restrictions under the Foreign Exchange Law, there are a number of measures designed to stem capital outflow and promote capital inflow.

One is the notification to securities companies in early March to suspend zero-coupon bond investments, a typical case of capital outflow. Since the commencement of sales from April last year until this February, they have been popularly received, with sales reaching 1,120 million dollars (780 million dollars in February) until halted by the Ministry of Finance.



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Also, on April 9, it directed the financial institutions and securities companies to hold back on foreign loans in yen and yen-denominated bond floatation. Hitherto, total limits had been set up on a half-year basis (560 billion yen for the first half and 790 billion for the second), but under the revised system, individual business plans will be checked starting the first half of 1982.

In actual terms, it implies an effort to hold the figure to under 560 billion yen. Also, the period of loans and floatation were shortened.

Further, the domestic sales of foreign CP and CD slated for were postponed.

In previous periods of a weak yen, capital inflow measures were constantly implemented, but there are fewer such moves now. It is because there is little left to do, and impact loans have been expanded and interest rates on free yen deposits liberalized.

Possible measures are expanding the sovereign tax exempt system granted to foreign governments and central banks to include stocks and relaxing restrictions on foreign stockholders in specific category or companies. However, not much expectation can be placed on this. One measure relatively effective is to expand the yen conversion limit at foreign banks, but as these are outside the control of the Bank of Japan, there are limitations, especially when considering the adverse effect on future policies in a period of tightening.

**Administrative Guidance Not Understood**

In the accompanying table, there are many items under the headings of permit system and reporting system. But an examination shows that, individually, none provides an immediate resolution.

A realistic judgment is that they can only restrict the acquisition of foreign securities by residents and check the outflow of investments. Strong measures will probably be taken against securities companies, life insurance firms and some companies dealing with real estate investments abroad.

In actuality, where banks are involved, it would be a simple matter to make them comply with the Ministry of Finance's "guidance," and the merits of preserving the exchange bank system can be demonstrated.

However, there still would be a problem. For, as evident in the "prohibition" of sales of zero coupon bonds, the substance of restrictions remains vague and obscure. Although the innovation of emergency provisions was warranted in light of developments and the aftermath, the reason for such action is unclear under the old type of administrative guidance.

It is natural for foreign sources unfamiliar with Japanese practices to cast a suspicion. Also efforts against a weak yen and for a strong yen

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are suspect. If emergency restrictions are needed, it is important to clarify the policy, method and its basis and then implement them. Otherwise, even a "treasured sword" will tarnish.

**Clarification of the Road Toward the Yen's Internationalization**

Another important point concerning the long-term stabilization of the yen exchange rate is the relation of liberalization of Japan's financial and investment markets and the internationalization of the yen.

The Ministry of Finance finds itself unable to come out strongly with emergency restrictions. This is because of fear of attack as being counter to liberalization and its desire to guard against expanding the battlefield of economic friction.

West Germany's Economic Minister Lambsdorff stresses: "The yen share of foreign currency reserves in the world's central banks is 4 percent and the mark's share 14 percent. From the standpoint of economic power, it is the reverse. The yen should perform its function as currency reserves, the means of international account settlements."

French leaders, including President Mitterrand, have proposed a tri-axis currency stabilization concept: "A fixed exchange rate within a specific floating range after getting the yen, dollar and European currencies together on some level." Even in the United States, frequent suggestions made are "a shift to the fixed exchange rate among countries having overcome inflation, with Japan's level at one dollar to about 170 yen."

The concepts and future plans all vary, but there is one point in common. That is, as "Japan enjoys a high status with almost 10 percent of the international economy, it should make sacrifices commensurate with it. The yen should reinforce the three functions of account settlements, reserves and intervention and perform the role of international currency."

**The Effective Tokyo Offshore**

Much of these assertions amount to pressure. But it is a fact that the yen's internationalization has proceeded at a pace faster than Japan had realized. For instance, the loan balance of Euroyen is estimated at nearly 5 billion dollars, and demand for yen for financing and applications is very high.

Against this, it cannot be denied that "Japan's capital market has been liberalized legally, but not liberalized with respect to application." (Mr Lambsdorff) It amounts to: "a Tokyo offshore banking center should be established and the market opened widely." (Taku Rosomi, president, Overseas Economic Cooperation Fund).

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For example, against the demand for yen funds, long-term loans or Euroyen and the issuance of Euroyen bonds could be liberalized. Or as a plan to limit fund demands to export-import transactions involving Japan or intermediary trade, a yen-denominated bank acceptance discount market could be established.

Further, with respect to desires for an arbitrage between the yen and other currencies, a Tokyo offshore market could be developed.

Of course, many kinds of disadvantages are possible in the yen's internationalization and change to a currency reserve. Over a long-term, the liberalization of the market and internationalization is a stabilizing factor, but over a short term, it is a disruptive material and the exchange market could act wildly. Also, it can become a constraint on invocation of domestic financial policies.

Nonetheless, a slow response due to apprehension over making the yen a currency reserve could hurt U.S. and European trust. We must not forget as regards trade friction that Japan's response, lacking long term concepts and invariably fragmented, was responsible for the gradual retrogression and deeper fissures.

The most effective "yen measures" would consist of formulating a long-term strategy on the yen's general role, to include the problem of how to return the surplus in current transactions to foreign countries, and offering a time schedule.

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Regulations in Force Under General Liberalization		
Permit System for Capital Transactions (Arts, 20, 21, Foreign Exchange Law)		
Deposits, trusts	Exchange bank is party	Ordinarily free (emergency restrictions) Permitted all times
	Others	Ordinarily free (emergency restrictions)
Cash loans/guarantees		Ordinarily free (emergency restrictions)
Transactions on measures for external payments	Exchange bank is party	Ordinarily free (emergency restrictions)
	Others	Permitted all times
Foreign exchange transactions among residents	Exchange bank is party	Ordinarily free (emergency restrictions)
	Others	Permitted all times
Acquisition of securities	Through designated securities companies	Ordinarily free (emergency restrictions)
Issuance and solicitation of securities	(Except Euroyen bonds)	Ordinarily free (emergency restrictions)
Issuance and solicitation of Euroyen		Permitted all times
Acquisition of real estate	Overseas acquisition by residents	Ordinarily free (emergency restrictions)
Fund transfer between main office and branches		Ordinarily free (emergency restrictions)
Other capital transactions		Free

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Reporting System for Capital Transactions and Others (Arts. 23, 23, 26, 27 and Others, Foreign Exchange Law)		
Cash loans	(Except direct overseas investments)	Prior notification (review and advise)
Cash borrowings		Prior notification (no review)
Guarantees at time of issuance of securities		Prior notification (review and advise)
Acquisition of securities (portfolio investments)	Acquisition of foreign currency securities from non-resident by resident	Prior notification (no review)
	Acquisition of securities from resident by non-resident	Prior notification (no review)
Direct foreign investments	Securities acquisition; loans	Prior notification (review and advise)
Issuance and solicitation of securities	Issuance abroad by resident; foreign currency securities	Prior notification (review and advise)
	Issuance in Japan by non-resident	Prior notification (review and advise)
Acquisition of real estate	Acquisition in Japan by non-resident	Prior notification (review and advise)
Direct domestic investments	Acquisition of stocks/interests by foreign investor	Prior notification (review and advise)
Acquisition of stocks of designated firms	Request for verification relative to acquisition of stocks	Verification
	Acquisition of stocks	Prior notification (review and advise)

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**ECONOMIC**

**THREE YEAR DECREASE IN NET FOREIGN CLAIMS REPORTED**

Tokyo NIHON KEIZAI SHIMBUN in Japanese 25 May 82 p 1

[Text] On May 25, Finance Minister Watanabe submitted to the cabinet a "Report on Foreign Loans" (as of the end of 1981) describing the loan situation between Japan and foreign countries. This report can be called the "Japan version" of the balance sheets prepared by enterprises at the time of account settlements. According to the report, Japan's net foreign claims outstanding, calculated by subtracting liabilities from assets, amount to \$10,918 million or 616 million less than at the close of 1980, a drop to one-third of the peak level (at the end of 1978). This means a decrease of net foreign claims for 3 consecutive years. Although the 1981 balance of payments showed a surplus for the first time in 3 years, the net foreign claims continued to decrease.

Japan's net foreign claims at the end of 1981 totaled \$209,257 million, exceeding \$200 billion for the first time since statistics came to be taken at the end of 1971. On the other hand, foreign debts totaled \$198,339 million. As a result, the net foreign claims, the difference between those two, decreased slightly from the end of the previous year. Such a decrease of net foreign claims, said to equal the equity of enterprises, is an indication of Japan's worsening external finances for the government and private sector.

Also, when compared with Europe and the United States, Japan's net claims of under \$11 billion are on the level of one-fifth that of the United States and one-third of West Germany (both as of the end of 1980).

In the past, Japan's net foreign claims outstanding varied, depending on the trend of balance of payments. For example, in 1979 and 1980 when the balance of payments showed a huge deficit because of the oil crisis, foreign borrowings were stepped up sharply to cover the deficits, resulting in greater foreign debts and decreased net claims.

The decrease of net claims at the end of 1981 despite the surplus in balance of payments is due to the inflated assessed value of external debts owing to changes in the yen rate.

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The yen was stronger by 32 yen when compared between the end of 1980 (\$1.00 = 242 yen) and the end of 1981 (\$1.00 = 210 yen). As a result, the assessed value of Japanese stocks held by foreigners leaped.

Because of stronger yen, the assessed value of net foreign claims also increased. As for the amount of increase due to change of valuation, the external liability is greater by about \$5.9 billion. On the other hand, as the 1981 surplus in the balance of payments, even after considering errors and omissions, is about \$5.3 billion, the difference of about 600 million represents a decrease of net claims.

Foreign Assets & Liabilities as of End of 1981  
(In million dollars; ( ) denotes decrease or liability over-run)

<u>Assets</u>	<u>End of 1981</u>	<u>Increase or decrease in 1981</u>
(Long-term assets)	117,090	29,209
Private sector	89,269	22,765
Direct investments	24,506	4,894
Deferred export payments	13,225	3,452
Loans	18,944	4,105
Securities investments	31,538	10,099
Others	1,056	215
Government sector	27,821	6,444
Deferred export payments	1,148	459
Loans	19,936	4,429
Others	6,737	1,556
(Short-term assets)	92,167	20,468
Private sector	62,912	16,865
Financial accounts	61,074	15,916
Others	1,838	949
Government sector	29,255	3,603
Financial accounts	29,252	3,604
Others	3	(1)
(Total assets)	209,257	49,677
 Liabilities		
(Long-term liabilities)	74,205	26,436
Private sector	53,608	18,384
Direct investments	3,915	645
Deferred export payments	5	(16)
Loans	1,478	(145)
Securities investments	47,852	17,628
Others	358	272

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Government sector	20,597	8,052
Loans	178	(47)
Securities investments	20,419	8,099
Others	0	0
(Short-term liabilities)	124,134	23,857
Private sector	117,110	23,124
Financial accounts	100,619	22,645
Others	16,491	479
Government sector	7,024	733
Financial accounts	3,922	64
Others	3,102	669
(Total liabilities)	198,339	50,293
(Total net assets)	10,918	(616)
Private sector	(18,537)	(1,878)
Government sector	29,455	1,262

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ECONOMIC

SMALLER FIRMS PLAN DROP IN INVESTMENT

Tokyo MAINICHI DAILY NEWS in English 25 Jun 82 p 5

[Text]

Investment in plants and equipment by Japan's small and medium-sized manufacturing firms totaled 1,765.7 billion (\$6.9 billion) in fiscal 1981, up 3.7 percent from a year before, according to a governmental financial institution.

The Small Business Finance Corporation predicted, however, fiscal 1982 investment by such manufacturing companies (with employees of between 20 and 299) will decline 21.8 percent to 1,390 billion yen (\$5.4 billion).

The figures were based on a survey of 12,555 out of Japan's 62,917 small and medium-sized manufacturing firms.

Of the projected plant and equipment investment in the current fiscal year, ending on March 31, 1983, the manufacturing firms plan an investment of 819.6 billion yen (\$3.2 billion) in the first half, down 6.2 percent, and 560.3 billion yen (\$2.2 billion) in the latter half, off 31.6 percent from a year ago.

Yukio Koide, deputy director of the semigovernmental corporation's economic research department, said, "They (the small and medium-sized manufacturing firms) are very cautious about their investment this year."

Machinery and electric machinery equipment firms, which together account for 21.5 percent of the total manufacturing firms, contributed 37.5 percent and 35.6 percent of the fiscal 1981 investment increase, the corporation said.

But apparel and related textile companies and lumber and wooden product firms, which together account for only 3.7 percent of the total, trimmed the overall investment growth with minus contribution shares of 11 percent and 30.4 percent each.

As for fiscal 1982 investment, Koide said the machinery and electric machinery makers will show drops of 25.9 percent and 23 percent in investment due to "sluggish" exports.

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ECONOMIC

BRIEFS

FREEZING OF PRICES--Agriculture, Forestry and Fisheries Minister Kichiro Tazawa Thursday asked an advisory body to study the advisability of his ministry's plan to set the producer prices of 1982 crops of wheat, barley and rye at the same level as in the previous year. If the plan is approved it will be the first time in 22 years that the prices of the grains have been frozen. The producer prices at which the government buys the grains from domestic farmers have been raised every year since 1955. The producer prices for 1981 crops were 11,047 yen (\$43.3) per 60 kilograms for wheat, 8,328 yen (\$32.6) for barley and 11,396 yen (\$44.6) for rye. The advisory body, the Rice Price Council, is expected to complete the study of the plan later Thursday. The ministry will formally announce the 1982 producer prices Friday. The ministry has decided to freeze the prices because of a swelling deficit in the food account. [Text] [Tokyo MAINICHI DAILY NEWS in English 25 Jun 82 p 5]

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**SCIENCE AND TECHNOLOGY**

**HEADS OF U.S. COMPANIES IN JAPAN VIEW SEMICONDUCTOR WAR**

**Different Business Customs**

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 20 Apr 82 p 5

[Article by reporter Nakano: "Desperate Battle Due to Differences in Business Customs; Understandings on the 'Differences' Varied"]

[Text] "There is no danger of rekindling the semiconductor friction between the United States and Japan" (Vice President Atsuyoshi Ouchi of Nippon Electric Company). The trade income and expenditure of both countries are roughly in balance and the tariffs have also been on an equal footing since April. As for capital investment and technical exchange, both countries have actively extended their routes into each other's territory. "We are not doing anything wrong, so why does the United States repeat anti-Japanese criticism so passionately?" Ouchi's opinion represents the consensus of Japan's semiconductor business circles. However, U.S. semiconductor manufacturers are strongly irritated by the "closed" nature of the Japanese market. So the views of the presidents of large U.S. companies in Japan, which constitute the spearhead for capturing the Japanese market were sought on the subject of "whether the Japanese market is really a closed market."

There is only one investigative report through which one can understand the true strength of U.S. semiconductor manufacturers in the Japanese market. This report, compiled by the Bank of America, is titled "The Actual Status of Japanese Semiconductor Business Circles." The semiconductor products "made in USA" which were sold in Japan's trillion-yen semiconductor market amounted to 85 billion yen, or no more than 10 percent of the share. Moreover, this was a reduction from 90 billion yen in 1980. Although this is much better than imported cars, which have a share of only about 1 percent of the Japanese market, the competitive edge that the U.S. semiconductor products had several years ago has fast become a "bygone myth."

#### Strong Consumer Demand

President Roy Seals of Japan NS (National Semiconductor) was interviewed first. Mr Seals took up this post last June after working as the managing director of an English plant. Although he was stationed at Tachikawa for 1 year as a member of the U.S. Army when he was 19 years old, "Japan was absent from my mind until I was ordered by Charley Spoke (president of NS) to become president of the Japanese company," he said. When asked "whether it is really so difficult to invade the Japanese market," according to the report compiled by the Bank of America, President Seals replied: "There is a 'thick barrier' in the form of differences in business customs." He felt keenly, after 10 1/2 months' experience in the semiconductor business in Japan, that "the consumer is strong and the manufacturer is subordinate to the consumer--in the 'position of a slave.'" Japan's business customs are quite different from those in the United States, where the consumer and the manufacturer deal with one another on an equal footing.

"In any case, the consumer's demand for service is very strict. The lead time on the product delivery date is extremely short. The response to the technical problem is pressed very hard. Demand for a discount is also very strong...." The trade conditions for semiconductors represented by the household electric appliance industry are extremely strict. However, precisely because there are consumers who make such severe demands, the Japanese manufacturers are used to the discipline and produce quality products, and, as a result, they are able to develop their competitive edge so much that they threaten the U.S. manufacturers.

Thereupon I asked President Seals: "If you give up because the consumer demand is harsh, then the U.S. companies cannot expect to increase sales. In Japan, you must adopt the Japanese style of marketing." He appeared somewhat offended by this question, but excused himself by saying, "I learned the first time I came to Japan to 'Do in Rome as the Romans do,'" and he went forward to make a fierce counterargument.

"Please do not misunderstand; NS is practicing a quality control which is as good as any Japanese rival's. Let me ask you a question. Suppose there are Japanese and U.S. semiconductor products which are completely identical in all aspects, including price, quality, and delivery date, which product would the Japanese consumer buy? Unfortunately, no Japanese consumer would sign a contract with the U.S. company. I personally inquired about a few large enterprises whose internationalization is quite advanced (he named specific names) and was told plainly we would never do such a foolish thing as to buy U.S. products if they are only comparable to the Japanese products."

#### Critical of Insufficient Effort

President Sadakiyo China of Mostec Japan was visited next. Mostec is a leading manufacturer in the field of memory products. However, it was late in developing the 64 Kbit RAM (random access memory) and allowed the Japanese manufacturer to get ahead. The details of the 1981 settlement of accounts were said to be quite miserable, so "the budget this year for the main office as well as for the overseas companies has been curtailed to a zero growth rate."

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Before taking up with Mostec Japan, President China worked as the product marketing manager for Intel Japan. He is a veteran of 15 years in the semiconductor business. Having also worked for the U.S. Amdahl Co, he is well versed in computers. When asked about "the differences in business customs represented by the manufacturer-consumer relationship," as pointed out by President Seals of Japan NS, he said flatly: "I agree with President Seals' opinion, because there is no concept of contract in Japanese society."

To be sure, there are contracts between manufacturer and consumer in the Japanese semiconductor business. What President China wanted to stress was the business custom practiced in Japan in which, "after the contract is signed, the consumer often breaks it without a qualm, and the manufacturer does not complain about the consumer's having broken the contract." It is difficult to explain such a state of affairs to the parent company, which is accustomed to a business atmosphere in which "contracts must be filled completely," and try to make them understand.

Thereupon I asked: "Do Japanese consumers discriminate against products made by foreign companies?" President Chino's reply was: "No." The business custom of Japanese semiconductor firms characterized by the nonexistence of contracts (or, more correctly, in which the contract, if it exists, may not always be fulfilled) applies equally to the Japanese manufacturers. "It is nonsense to complain that 'Japan is a closed market' without making a reference to the insufficient efforts of the foreign-capital manufacturers. Companies such as ours, which do not have a plant in Japan and are troubled by the exchange rate, are quite helpless vis-a-vis the consumers," he added.

President (Katabiki) Kamo of Intel Japan has a different opinion from those of the two gentlemen interviewed previously. Intel was the company that developed the first microcomputer. President Kamo, who was a commercial firm man (Nissho-Iwai Company Ltd; Tokyo Electron), has been acquainted with Chairman G. Moore and Vice Chairman R. Nois of Intel since the time these two gentlemen became independent of Fairchild. He was scouted to be the president of Intel Japan when it was started 6 years ago. They began preparing for the production of semiconductors in Japan last year by transferring various main office departments to the Chikuba Research and Educational town in Ibaraki Prefecture.

**Superior Technology Goes**

"Speaking of Japanese consumers being harsh, the situation is the same in the United States. In Japan, as in the United States, if one holds onto such a narrow viewpoint, he cannot be victorious in dealing with IC products, which demand a worldwide viewpoint and marketing strategy." President Kamo stated clearly: "It is evident that the IC import business will be affected by the fluctuating exchange rate for the yen, and it is rather natural that Japanese consumers should prefer Japanese products, because they have had a much longer association with them in the past." He added: "I have never thought of the Japanese market as being closed."

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Intel has captured the Japanese market in its world strategy. "It is always difficult for foreign products to make inroads in other countries, no matter what country it may be. It is the same in the semiconductor business. Intel is a technology-oriented company. We believe that we can win the race of ever-advancing semiconductor development if we can introduce products which are technologically advanced. This can be seen from Intel's success in winning the lead and share struggle in the continuous development race since its commercialization of the microcomputer," stressed President Kamo.

**Japanese Companies Receive Subsidies and Financial Favors**

NS President Charley Spoke rates Japan highly as a rival. Japanese semiconductor manufacturers have made the best use of mass-production technology and concentrated their investments in the field of memory, thus earning huge profits. However, Japanese manufacturers have been able to accomplish this feat because of the government subsidies they have received and the financial favors bestowed on them. Three concrete examples will be cited.

First of all, on financial matters: Usually the interest on a loan increases rapidly. However, Japanese financial organizations are very generous toward Japanese semiconductor manufacturers, allowing low interest rates over an extended period of time. Moreover, the interest rate is even lower for equipment investments over an extended period of time.

Secondly, the government subsidy: The Japanese Government helped establish the semiconductor industry and, during the development period, conducted cooperative research and development activities.

Thirdly, the Japanese Government cooperates with the semiconductor industry in the fight against U.S. manufacturers.

(Note) These were the written responses to the questions asked by this reporter. President Spoke, who is at the forefront of the anti-Japanese critics in connection with the U.S.-Japanese semiconductor friction, has consistently avoided Japanese reporters.

**Complicated Circulation Mechanism**

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 21 Apr 82 p 7

[Article by reporter Nonaka: "Troubled Because of Complicated Circulation System; Strong Controls by U.S. Main Office Are Shackling"]

[Text] "Look at the successful example of TI (Texas Instruments)." As a rule, the name of TI is mentioned whenever MITI wants to stress the fact that Japan is not a closed market by pointing out that there are numerous foreign capital semiconductor manufacturers which are successful in Japan. TI is the world's largest manufacturer of semiconductors, with headquarters in Dallas, Texas, and 40 overseas plants in 19 countries.

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Nippon TI was established in 1969, capitalized entirely by TI. Today there are four plants, including the Miho plant in Ibaraki Prefecture which started operation last January as the super LSI (large-scale integrated circuit) mass-production stronghold. The fact that all aspects of Nippon TI, including productivity, profit rate, and quality, are unsurpassed by any other plants in the TI group has been recognized by the parent company. The mass-production tempo is quickening at the Miho plant, which is the supply base of the 64 Kbit RAM.

Nippon TI has certainly taken root securely in Japan. The Hatagoya plant in Saitama Prefecture was started at the time [of Nippon TI's establishment], and in 1973 the Hinode plant in Oita Prefecture went into operation. In 1979, the Koyama plant in Shizuoka Prefecture started turning out products related to control machinery, and then the Miho plant in Ibaraki Prefecture started operation. The confidence of Nippon TI, which is entrusted wholeheartedly by the U.S. main office with the mass-production of advanced technology products such as the 64 Kbit RAM and 16-bit microcomputer, is quite enormous.

This Nippon TI "success story" can also be interpreted to mean that it is necessary to take this long in order to succeed in Japan. Many presidents of U.S. companies in Japan are unanimous in their opinion that one of the difficulties encountered in conducting business in Japan is Japan's complicated circulation mechanism.

The "Gibbons Report" compiled last December by the Trade Subcommittee of the U.S. Congress Finance Committee (chairman, S.M. Gibbons) argues "the necessity to counter Japan's challenge." It describes Japan's circulation mechanism as "utterly incomprehensible" and states that "the simplest way to join the Japanese market is to purchase an enterprise." I asked Vice President Kenichi Yoshida of Nippon Motorola to explain the differences between the Japanese and American circulation systems.

**Too Many Intermediates and Too Much Expense**

Nippon Motorola was started on 1 January when three subsidiary companies capitalized entirely by Motorola merged. Although George Needham, who is in charge of the Asia-Pacific Region of the Semiconductor Business Department in the U.S. main office, was appointed president, Japanese staff member Yoshida, who had worked as a resident Motorola representative in Japan until last year, is for all practical purposes in charge. He was originally a banker (from the Bank of Tokyo) but was scouted in 1963 to work for Motorola Service in charge of supplying materials.

"The biggest difference between the Japanese and American circulation mechanisms is the fact that there are very many intermediate operators in Japan. Moreover, old personal relationships and debts of gratitude have taken root. It may be an exceptional example, but in some districts no product can be sold unless it is handled by a certain wholesale boss, who keeps a firm grip on the area." In the U.S. market, too, there are intermediates, called distribution representatives, who handle semiconductor circulation, or large electronic parts sales firms such as Hamilton Abnet which cover the entire United States.

Vice President Yoshida considers that there is "too much power in the hands of the intermediate operators in Japan who engage in marketing activities." It is "unbelievable" to a U.S. manufacturer that 95 percent of the semiconductors sold domestically by Nippon Electric, Japan's largest manufacturer, are handled by 13 agents. Moreover, the circulation expenditures, including the commission paid to the intermediate operators are too voluminous.

In the semiconductor business, in which the effect of mass production can be significantly demonstrated, it is also a race for cost-down. To knock down your rival company, you must be able to sell cheaper, even by 1 yen. Another reason why it is difficult for U.S. companies to operate in the Japanese market is the fact that in negotiating the price with the consumer, they have to consult their main office in the United States via telex and obtain approval. In doing so, some may have lost the opportunity to win out. I asked President Yoshida whether the U.S. company in Japan has the right to make decision on matters related to price.

#### U.S. Companies in Japan Have No Rights

"Nippon Motorola was granted the right to negotiate the price with the consumer 5 years ago. However, strategic products are still under the control of the U.S. main office." It must have been very difficult to gain the right to make decisions on matters concerning the price in the Japanese market from the U.S. enterprises, which are especially nervous over the price policy because of "the Antitrust Law."

The strong control exerted over U.S. companies in Japan by their respective U.S. main offices is a phenomenon common to all companies. An interview with Fairchild Japan, the U.S. company in Japan that is the world's seventh largest semiconductor manufacturer, which decided to build a plant at Isahaya City, Nagasaki Prefecture, in February, did not materialize precisely because of this "wall." President Robert Scaco of the company was so thorough that he even refused to answer questions concerning "production capacity and sales volume" at the press conference when the announcement of the new plant was made.

A certain semiconductor consumer pointed out: "Negotiations with a U.S. company in Japan are quite different from negotiations with a Japanese company. First of all, the procedure is troublesome, because the U.S. company in Japan does not have the power to make decisions. There is no room for 'maybe.' And there is some sort of secrecy." The more successful that U.S. companies such as TI and Intel are in Japan, the more independent these U.S. companies are from their respective main offices in the United States.

#### Human Resources Who Talks Back to the Main Office

What must foreign capital semiconductor manufacturers do in order to be able to break through the "narrow gate" of Japan's semiconductor market?

(Atsuhiko) Kohara, who resigned as an acting director of the business department and as director of business strategy from Motorola's company in



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Japan and became the president of Krestonix (phonetic), a subsidiary of Electronix, was then asked to appear. "Unfortunately, the U.S. main office does not understand the Japanese market very well. If they attach any importance to the Japanese market at all, they should install someone who can clearly talk back. So many presidents are led by the nose by their U.S. main offices. First of all, therefore, it is a question of personnel. It boils down to how talent should be cultivated. On the side of business, the Japanese companies have just caught up with the U.S. companies in the fields of memory, microcomputers, and MOS (metal oxide semiconductors). The U.S. companies are a cut above Japanese firms in the bipolar field. The U.S. firms also have a day's lead in software technology. Paths can be opened if the U.S. companies will compete in the market of superior technology," Mr Kohara suggested.

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SCIENCE AND TECHNOLOGY

HYDROGEN ENERGY RESEARCH, DEVELOPMENT DISCUSSED

Manufacturing, Storing Technologies

Tokyo SHUKAN TOYO KEIZAI in Japanese 3 Apr 82 pp 76-81

[Article by Y. Ohtori, scientific commentator]

[Excerpts] In the Sunshine Plan, which was inaugurated upon the first oil crisis, the research and development of hydrogen energy technology was chosen as one of the projects to be solved on a long-term basis.

Even prior to the oil crisis, however, the major problem of ever-increasing pollution related to the increased use of fossil fuels was affecting the living environment. The origin of the concept of hydrogen energy which is currently being developed, and which is attracting attention, can be traced back to that time. It was initiated in the United States.

However, a leading proposal for the hydrogen energy era was published 2 years prior to that, in 1970, in an article "Liquid Hydrogen, Fuel of Tomorrow" by Professor T. Ohta of Yokohama National University in Japan. Also in Europe about that time, a new method to decompose water by means of nuclear heat was proposed by Dr Maltecci [phonetic], who was then chief of the materials division of the Ispra Research Laboratory of the European Atomic Energy Community.

Thus, the two parties have come to cooperate toward the realization of the new energy system using hydrogen as the energy medium. The eddy that was stirred up in Japan, the United States, and Europe aiming for hydrogen energy is about to become a rushing flow.

The World of 3E That Exceeds Electrical Energy

Hydrogen is the substance with the simplest structure. It is the lightest of all the gases, and its weight is approximately one-fourth that of air. Because it is light, hydrogen (generally called light hydrogen) has the greatest diffusibility among all the gases, and it rapidly diffuses even into substances such as metals. This [diffusion] property is very important for the utilization of hydrogen.

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Electrical energy, like hydrogen, is secondary energy processed for the convenience of use as a primary energy. It has been used fully as good quality energy because it is (1) clean and (2) readily convertible to other forms of light, thermal, mechanical, and chemical energies.

However, there are also some drawbacks. They include the fact that (1) the transmission loss is high; (2) it is difficult to store and the storage loss is high; (3) its area of utilization as a substitute for oil is limited due to low efficiency, as in batteries, and due to uncompleted technical progress, etc. On the other hand, hydrogen energy holds great expectations as an energy that covers the shortcomings of electrical energy.

The reasons are (1) the raw material, being water, is not restricted as a resource; (2) when the combustion temperature is controlled, the combustion product is water; it is a clean energy and emits no pollutant gases, since it cycles by returning to its original form; (3) in the case of fossil fuels, the constituent element, carbon, has a long cyclic period, whereas the hydrogen cyclic period of hydrogen forming from water and returning to water is fast, and the cyclic system of substances on earth is not disrupted; (4) transportation and storage are relatively easy, and their losses are small; and (5) it is usable in areas where oil is being used as a heat source--such as for power generation fuel, city gas, industrial furnaces, jet fuel, etc.

If we cite additional merits, (6) it has a high output, as seen in its use as second- and third-stage rocket fuel for launching Saturn rockets or space shuttles; and (7) price stability can be expected in hydrogen fuel (the raw material is water; if solar energy is used for the process, the hydrogen cost includes only the amortization of the facilities and operational expenses--unmanned operations are feasible).

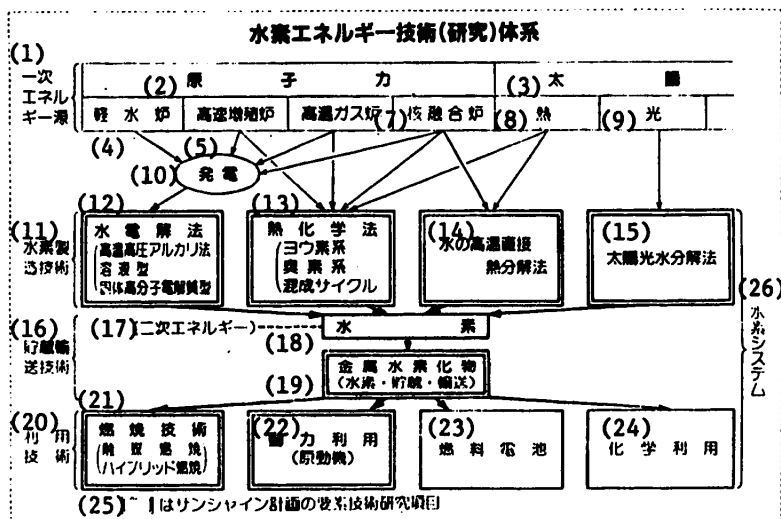
These are the advantages of hydrogen as an energy medium. Professor Ohta points out that "the diversified application of hydrogen will produce an overall economical condition as an economic system," and "the characteristics of hydrogen energy system can be enumerated by combining the '3E's'--"ecological," "energetic," and "economical."

The basics of a hydrogen energy system are (1) to manufacture hydrogen from water through a primary energy process, and, in order to develop the produced hydrogen into an industrial system, (2) mass storage and transportation must be realized easily, safely, and economically. Furthermore, it is necessary to ensure the effective use of power, chemical, and energy applications at the final destination.

When items (1) through (3) become technically feasible, the hydrogen energy system, whose goal is a hydrogen economy, will be realized for the first time. Aiming for that realization, the Sunshine Plan has since 1974 been advancing research and development of "elemental technologies" of technical systems, as shown in the figure.

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## Hydrogen Energy Technology (Research) Structure



## Key:

- |   |   |
|---|---|
| 1) primary energy sources   | 14) high-temperature direct pyrolysis of water  |
| 2) nuclear power  | 15) solar photolysis of water   |
| 3) solar  | 16) storage and transportation technology   |
| 4) light water reactor  | 17) (secondary energy)  |
| 5) fast breeder reactor   | 18) hydrogen  |
| 6) high-temperature gas-cooled reactor  | 19) metal hydrides (hydrogen, storage, transportation)  |
| 7) nuclear fusion reactor   | 20) application technology  |
| 8) heat   | 21) combustion technique (catalytic combustion, hybrid combustion)  |
| 9) light  | 22) power application (prime mover)   |
| 10) generation of electricity   | 23) fuel cell   |
| 11) hydrogen manufacturing technology   | 24) chemical applications   |
| 12) electrolysis of water (high-temperature, high-pressure alkaline technique, solution type, solid high-molecular electrolytic type) | 25) <span style="border: 1px solid black; padding: 2px;"> </span> is for research items of essential technology in the Sunshine Project |
| 13) thermochemical technique (iodine system, bromine system, hybrid cycle)  | 26) hydrogen system   |

## South Pacific Raft Project

The current status of the "hydrogen manufacturing technology" will be discussed next.

(1) Electrolysis of water: It is an old method, but there is a problem cost-wise.

(2) Thermochemical process: The reaction is carried out under thermal conditions of below 1,000°C, mediated by compounds of iodine, bromine, etc, by com-

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binning several thermal chemical reactions while cyclically using the above substances and decomposing water into hydrogen and oxygen as a whole.

(3) High-temperature direct pyrolysis of water: Since electrolysis of water is carried out through a three-step conversion of thermal energy-mechanical energy-hydrogen energy, the overall efficiency is about 50 percent. Therefore, the goal is to upgrade the efficiency drastically by developing a one-step process of thermal energy hydrogen energy.

Water breaks down into hydrogen and oxygen at a high temperature. However, it is difficult to separate hydrogen quickly from water vapor at the high temperature of 3,000°C. Currently, studies are being conducted using various kinds of separation membranes such as ceramic membranes that endure superhigh temperatures.

(4) Solar photolysis: This is a process for manufacturing hydrogen in which metallic catalysts that allow high absorption and utilization of light energy are used along with micro-organisms such as algae and photosynthetic bacteria. When the light energy of the sun is converted to electricity with a photo-electric converter element (light-sensitive semiconductor) such as a solar cell, voltage of about 1 volt can be obtained. This low voltage can be used very efficiently to decompose water.

Thus, studies are being made on various processes using soft energy. One of them is the "PORSHE Plan." The official title is "Plan of Ocean Raft System for Hydrogen Economy." It is a joint U.S.-Japanese development project proposed by Professor Ohta and Professor T. N. Bezeroglu [phonetic] of the University of Miami, among others.

The substance of the plan is to float a giant raft measuring 2 square kilometers for the purpose of collecting solar energy in the South Pacific just below the equator, and to manufacture hydrogen from seawater by using the above energy. In Japan, a model raft is being used for research at Yokohama National University, and studies are being advanced with the Electrotechnical Laboratory of the Industrial Science and Technology Agency in the lead.

According to Professor Ohta, "In a sea area twice the size of the Japanese archipelago centered at latitude 8° south and longitude 138° west, where there are the highest number of partly cloudy days, a world economy of complete independence from petroleum can be materialized by obtaining proper efficiency in the conversion of solar energy poured on the area. The method of energy conversion is very important. On the ocean, the urgent need is to change the seawater to hydrogen and oxygen with the electric power generated, to establish a concrete energy conversion process that utilizes the above products as energy media (secondary energy), and to provide for an ultimate energy system."

However, standing in the way of the development of a hydrogen economy is the hitch in storing and transporting hydrogen.

Presently, transportation and storage of hydrogen are generally carried out in the gaseous state. This is inefficient, since large-capacity tanks and cylinders that are very heavy compared to their contents are being used. Although pipe-

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lines are promising for mass transportation, it is necessary to develop an inexpensive, high-strength material that has little chance of becoming deteriorated by the hydrogen.

**Metals That Occlude and Release Large Amounts of Hydrogen**

On that morning, the materials laboratory of Matsushita Electric's central research laboratory (director: Dr S. Hayakawa, managing director) in Moriguchi City, Osaka Prefecture, was enveloped in excitement and joy. The research staff had discovered, upon coming to work, that the pressure in a sealed container, in which a small amount of titanium-manganese alloy and 10 atmospheres of hydrogen had been placed the night before, was down to less than 1 atmosphere. Careful inspection revealed no trace of hydrogen leakage. The alloy had indeed occluded the hydrogen. This occurred at the end of 1974.

The metal that occluded the hydrogen is called a "metal hydride." It was first developed by Phillips in Holland in the late 1960's. It is a compound in which hydrogen atoms enter the spaces between the atoms that constitute the metallic substance. Hydrogen atoms readily penetrate and move about in metal, and because of that property of hydrogen, a unique phenomenon occurs.

A metal hydride is literally a compound of metal and hydrogen. For about 10 years, research has been in progress on two unique properties of metal hydrides: (1) the relationship of pressure-temperature-composition in the processes of occlusion and release of hydrogen by metals or alloys, and (2) characteristics with respect to the velocity of chemical reactions in those processes. As a result, it has gradually been revealed that various possibilities in engineering applications are in store by the skillful incorporation of such characteristics.

The maximum amount of hydrogen that can be occluded in a certain type of metals is unexpectedly large, and it was revealed that the density is very high even in comparison to hydrogen packed in a heavy cylinder compressed at a high pressure of over 150 atmospheres, or hydrogen liquefied at an extremely low temperature. Furthermore, the speed of occlusion is as rapid as several minutes; under ideal conditions it can be as fast as several tens of seconds.

**Wonders of Lanthanoid Alloys**

Metal hydrides having such various characteristics can be used for new storage and transportation methods of hydrogen as well as for a separation process to separate and purify only hydrogen (since metals occlude only hydrogen) among other gases, for energy storage and conversion based on chemical reaction, and in other versatile ways.

There are various kinds of metal hydrides. Those that can occlude a large amount of hydrogen were developed almost simultaneously toward the end of the 1960's: first, a lanthanum-nickel alloy at the Phillips Research Laboratory in Holland, and an iron-titanium alloy at the Brookhaven National Laboratory in the United States. They allowed hydrogen occlusion in densities of at least 1.3-1.4 greater than the density of hydrogen atoms in liquid hydrogen. However,

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the practical application did not materialize: in the former case because of the high cost of lanthanum, and in the latter case because of the troublesome pretreatment required for occlusion.

Regarding the mechanism by which hydrogen is being incorporated into alloys, there is a study by Professor Ohrus [phonetic] of the Department of Chemistry, University of Pittsburgh, on the subject of lanthanum-nickel alloys.

According to the report, lanthanum oxide ( $\text{La}_2\text{O}_3$ ) and lanthanum hydroxide ( $\text{La}(\text{OH})_3$ ) are clustered at the thin-layer surface of the alloy, and the spaces are filled only with nickel. Lanthanum-5-nickel ( $\text{LaNi}_5$ ) alloy lies beneath that.

First, external hydrogen molecules ( $\text{H}_2$ ) approach the surface of nickel or  $\text{La}_2\text{O}_3$ . As the pressure of hydrogen gas is increased, the spaces between hydrogen molecules are reduced and the number of adhering molecules increases. Using pressure as the propulsion, hydrogen is adsorbed first in the nickel layer in a type of chemical adsorption (chemical adsorption is a phenomenon among those of solid surface adsorptions that are caused by chemical bonding forces).

The hydrogen molecules thus chemically adsorbed into nickel returns to the atomic state subjected to the surrounding  $\text{La}_2\text{O}_3$  and  $\text{La}(\text{OH})_3$ , and the hydrogen molecules' bonds are broken. This hydrogen in its atomic state diffuses deeper inside, through the border areas of nickel and  $\text{La}_2\text{O}_3$  or  $\text{La}(\text{OH})_3$ .

Hydrogen atoms that approach  $\text{LaNi}_5$  in this manner settle in the positions of lattice spaces of alloys (elements composing alloys occupy the lattice inter-sections) in their atomic form.

#### Development of Various Alloys

In summary, the important facts are that the hydrogen molecules change from molecules to atoms in the process of penetration from the surface to the inside, that chemical adsorption shifts to diffusion, and that hydrogen finally occupies the positions of lattice spaces. The speed of this three-step process is none other than the hydrogen occlusion speed of the alloys. How much this speed can be upgraded is related to the practical application of the metal hydrides, and is the big project in metal hydride research.

To have hydrogen released from metal hydrides, one needs only to change temperature and pressure, and the hydrides then return to the original metals or alloys by the release of hydrogen.

The requisites of hydrogen occlusion alloys are: (1) a large occlusion and release rate for hydrogen; (2) the ability to occlude and release hydrogen without high temperature and high pressure; (3) maintenance of performance and long life, even with repeated hydrogen occlusion and release; (4) a rapid occlusion speed; (5) high occlusion stability; and (6) availability at low manufacturing cost.

The metals used for hydrogen occlusion began initially with a unary system--namely, one kind of metal component--then shifted to binary alloys such as

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titanium-iron, and now have reached quinary alloys. The appearance of a sextet system is expected in due course. In all cases, the work centers on the selection of the proper elements to alloy and how to vary their ratios.

Specifically, available alloys include iron-titanium alloys, lanthanum-nickel alloys, magnesium-nickel alloys, misch metal (mixture of rare earth elements) systems, titanium-cobalt systems, etc.

The iron-titanium systems have the advantages of being the most inexpensive and repeatedly usable. At the time of the initial hydrogen occlusion, however, its speed of reaction with hydrogen, is slow, and thus it has the disadvantage of requiring pretreatment to activate the system by allowing long hours of contact with hydrogen under high-temperature and high-pressure (400°C, 65 atm.) conditions. However, Japan Metals & Chemicals Co, Ltd, in collaboration with the Ulvac Corporation, has successfully developed new iron-titanium alloys. This is an unprecedented system which can be pretreated at normal temperature and 35 atmospheres.

On the other hand, the National Research Institute for Metals, of the Science and Technology Agency, has developed a system that does not require pretreatment for activation by adding a small amount of niobium to the titanium-iron alloy. New alloys of an inexpensive titanium-iron system that do not require activation pretreatment are being developed competitively all over the world.

A magnesium-nickel system is inexpensive, and the hydrogen occlusion volume is large. But it does not release hydrogen unless heated to above 250°C, and the activation treatment is also difficult.

**"Epochal" Achievement by Matsushita Electric**

Among the Japanese research achievements recognized as top-level products, there is the titanium-manganese alloy of Matsushita Electric. Since about the time hydrogen occlusion alloys were first studied in Europe and the United States in the late 1960's, the above company has been in touch with research involving hydrogen occlusion of metals, but not with the intention of studying metal hydrides.

In the process of studying thin-film formation techniques by sputtering (a phenomenon in which atoms of metal heated in low-pressure gas sputter into the gas and adhere to nearby solid surfaces), Director Hayakawa and others of the above-mentioned materials laboratory discovered that a marked hygroscopic effect is displayed by some thin-films among the titanium oxide thin-films formed under certain conditions.

With this as the turning point, research has been advanced, and partial results were published in September 1970 in the journal of the Japanese Society of Applied Physics. An indirect result of the research became the lever for the development of a new hydrogen storage system, and in the summer of 1978, Matsushita Electric Industrial Co announced that it had "successfully developed an epochal solid hydrogen storage substrate in which a gas can be electrically stored in metal."



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According to trial calculations, the volume of hydrogen that can be occluded in 1 cubic centimeter is 2,000 cubic centimeters at 1 atmosphere. In other words, it is possible to hold 20 times more hydrogen than with the 100-atmosphere cylinder then being used. However, this method of hydrogen occlusion is different from that of the so-called hydrogen occlusion alloy, and because it requires a high temperature of 400-500°C to release the hydrogen, there has been no practical application.

However, this development was not in vain, but helped the research group of Matsushita Electric to be alert for the development of hydrogen occlusion alloys before any other firms, and the energy conversion technique research laboratory was established in affiliation with the central research laboratory.

In 1974, they achieved good results with the above-mentioned titanium-manganese alloys. By making further progress in development, they discovered that 1.5 titanium-manganese alloy is the optimal composition of titanium-manganese alloys, and the quinary alloy of titanium-zirconium-manganese-chromium-vanadium, with a unique composition ratio among the titanium-manganese multielemental system alloys, has superior characteristics as a hydrogen storage material.

The titanium-manganese binary alloy which was developed by the company in 1974 occludes hydrogen very readily, even at normal temperatures. The quinary alloy is a further improved alloy over the binary alloy.

#### Hydrogen-Fueled Engines and Fuel Cells

On 11 March, Matsushita Electric revealed that it has entered into a collaborative agreement with Daido Tokushuko [Daido Special Steel] to commercialize hydrogen occlusion metal technology. [Matsushita] will supply the titanium-manganese alloy technology and Daido will produce the alloys, using a plasma melting furnace of its own design, and market the product. Industrialization of this type of technology is the first in the world, and they are aiming for commercialization within 2 years.

The 1.5 titanium-manganese alloy can theoretically occlude 1,400 cc hydrogen per 1 cubic centimeter. Moreover, both occlusion and release are possible at normal temperatures. This is approximately equivalent to 1,400 atmospheres, and it means that the size of storage vessels can be reduced to a fraction of the conventional high-pressure cylinders. The collaborative agreement of the two firms allows for speculation that, although in part, the "era of effective hydrogen application" and the "era of metal hydride application" are near.

Such signs are also appearing elsewhere. Sumitomo Metal Industries, Ltd has begun producing hydrogen gas. Production of hydrogen for the manufacture of iron began in June of last year at its Kashima plant, and a hydrogen production plant will be completed in July of this year at the Wakayama plant for full-scale distribution to the outside market. For that reason, technical development in the use, storage, and transportation of hydrogen has been advanced.

Along these lines, it was revealed that three firms of the Sumitomo Metals Group--Kyodo Sanso, Sumitomo Seimitsu Kogyo, and Chuo Denki Kogyo--collaborated

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in the development of a bike that uses gaseous hydrogen as fuel, and that a trial run was successfully completed last January. It is a modified 49-cc Honda Super-cub using a dilute hydrogen combustion system. Hydrogen was occluded in an iron-titanium alloy and loaded as a metal hydride.

It has been proven that hydrogen can be stored in a light, safe, and efficient manner compared to conventional cylinders. The hydrogen fuel container with an internal volume of 500-cc that has been used can store only 5 liters of hydrogen when the gas is packed at 10 atmospheres. Compared to that, a 500-cc iron-titanium alloy can store 200 liters, a 40-fold increase in hydrogen storage capacity. This has made it possible to mount the alloy container on the bike.

In Japan, the Mechanical Engineering Laboratory of the Industrial Science and Technology Agency has for 4 years been developing automobile engines that use hydrogen fuel. In addition, Professor S. Furuhashi of the Musashi Institute of Technology began developing a hydrogen-fueled car that was developed and won a prize for covering 3,000 kilometers in 5 days. It has also been proven that hydrogen fuel is more efficient than gasoline and that the exhaust gas is also much cleaner.

**Japan Behind in Basic Research**

In the United States, its use as an aircraft fuel is also being planned. Besides as engine fuel, the use of metal hydrides is extensive. They are expected to play a major role in the practical application of electric generation using fuel cells--for which a large-scale trial application has been begun by Tokyo Gas Co and Osaka Gas Co. Its uses are versatile in areas related to industry and daily life, and include driving and cold-storage application systems for heat pumps with a static compressor of metal hydride application, the hydrogenation reaction of organic compounds, etc.

Along with such trends, it has become urgent to upgrade the performance of metal hydrides; this is the cardinal point in the application of hydrogen energy. In keeping with these steps, competition in the search for a new alloy to break the shell of the currently used alloy for storing hydrogen has become fierce among the top-level organizations in this field, such as the Brookhaven National Laboratory in the United States, Philips in Holland, and Battelle in Switzerland.

To make a big leap, basic research must first be substantiated in depth and breadth. All leading overseas research organizations that are engaged in hydrogen energy work have outdistanced Japan in taking steps in this regard. Partly because of the delayed start, Japan has been leaning toward search and study in order to catch up. It has apparently become necessary to alter this posture considerably.

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Hydrogen Occlusion Alloy

Tokyo SHUKAN BIRION in Japanese 23 Apr 82 pp 39-41

[Article by Y. Ariga, scientific commentator]

[Excerpts] Hydrogen Energy To Shoulder Next Generation

On that morning, the materials laboratory of the Matsushita Electric's central research laboratory in Moriguchi City, Osaka Prefecture, was filled with joy and excitement and tension over what was to come. Upon coming to work, the research staff had discovered that the pressure in a sealed container, in which a small amount of titanium-manganese alloy and 10 atmospheres of hydrogen were placed the night before, was reduced to less than 1 atmosphere. Careful inspection revealed no trace of hydrogen leakage. Thus, as expected, the alloy had indeed absorbed the hydrogen. The experiment was clearly a success. The time was the end of 1974.

Eight years later, in March 1982, a related source revealed that Japan had begun ahead of other countries to undertake full-scale commercialization of a "hydrogen occlusion alloy" that can adsorb hydrogen gas in a large quantity for storage and release as needed. This caused a big ripple among related sources for hydrogen occlusion alloy research both at home and abroad.

This was the news that Matsushita Electric and the leader in the special steel circles, Daito Tokushuko, had recently formed an agreement whereby Matsushita Electric will provide Daito with the leading technology of a titanium-manganese system hydrogen occlusion alloy that it had developed, and Daito will manufacture this "hydrogen occlusion alloy" by using a plasma melting furnace of its own development. Daito obtained the related patents and marketing rights at home and abroad, and plans to move on to commercialization within 2 years to market the hydrogen occlusion alloy at 5,000-6,000 yen per kilogram.

Hydrogen is a well-known clean energy source, and its advantage is that the combustion exhaust material is water, as long as the combustion temperature is not unduly high, and that, unlike carbon system fuels, it does not produce carbon dioxide or carbon monoxide.

It has become commonsense for knowledgeable people to view the real, long-term energy source that is to follow fossil fuel energy to be hydrogen, while atomic energy (except nuclear fusion energy) is merely for provisional use to bridge the two energy sources. The representative proponent of this concept is Professor T. Ohta of the Faculty of Engineering, Yokohama National University. Ten years ago, a "hydrogen energy system" was evaluated as part of a series on national economics at the "Seventh Conference on Energy Conversion." It is feasible to convert the existing facilities that use fossil fuels, ranging from vehicles such as automobiles to industrial and household energy sources and power sources, to hydrogen energy use. The director of the Oak Ridge National Laboratory, A. W. Weinberg predicts that "in the end, civilization will depend on hydrogen for energy."

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Thus, even the term "hydrogen economy" has appeared, and the arrival of the hydrogen era has now become a matter of time. Accurately speaking, hydrogen is not an energy source. It is an "energy carrier," and to make hydrogen, we need solar energy (primary energy), thermal energy, and electric energy. Therefore, hydrogen energy is called "secondary energy" along with electric energy. In the case of electric energy, electric wires are used for transmission, while hydrogen energy can be transported in pipes. The big problem, however, is how to store the hydrogen.

As a gas, even when it is packed in a high-pressure cylinder at 150 atmospheres, a heavy cylinder weighing 55 kilograms can hold only 57 liters of hydrogen. In this state, there is no prospect for a general practical application.

Even though hydrogen is clean and may be manufactured inexpensively in large quantities, it cannot be used as a power source for passenger airplanes, automobiles, motorcycles, and at worksites unless it can be stored and transported in a stored, package form. It is not impossible to convert it to a liquid fuel; however, this is not cost-effective unless it is for use as a fuel for space rockets, etc. Even with the currently used LNG [liquid natural gas], the required temperature is  $-162^{\circ}\text{C}$ , and in the case of liquefied hydrogen, it is  $-252^{\circ}\text{C}$ , which is nearly absolute zero ( $-273^{\circ}\text{C}$ ). When the cost to lower the temperature and the cost to maintain that temperature in a container are added, it is not economically profitable. Hydrogen as a liquefied fuel has no *raison d'être* unless it wins the competition against petroleum, LNG, alcohol, etc.

Hydrogen is being transported and stored for the most part in a compressed gas form, using high-pressure cylinders or tank trucks. However, as mentioned above, the efficiency is low and this has been a big barrier to the realization of a hydrogen energy era.

Therefore, the competitive development of a new technology to store and transport hydrogen in large quantities by occlusion in special metals has been in progress in the United States, Europe, and Japan. At any rate, hydrogen is a substance that has the simplest structure and is the lightest among all gases; entering into substances such as metal, it rapidly diffuses. This characteristic is also the key to the occlusion of hydrogen. The metals that can occlude hydrogen well are called "metal hydrides."

## Comparison of Hydrogen Storage Volumes

Name		Hydrogen Storage Volume (gram/ milliliter)	Energy Density (hydrogen combustion heat) (calorie/mil- liliter)
Metal			
Hydride	TiH <sub>2</sub>	0.152	5153
Examples	MgH <sub>2</sub>	0.106	3593
Liquefied Hydrogen		0.07	2373
Compressed Hydrogen (100 atmospheres)		0.007	244

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**Hydrogen Occlusion of Superior Metal Hydrides**

The requisite properties for a superior hydrogen occlusion (metal) alloy include (1) a high hydrogen-occlusion ability; (2) an activation (a pretreatment to enable hydrogen occlusion and release at any time) process that is simple and easy; (3) small heat production of metal hydride (chemical reaction heat produced in the process of metal and hydrogen reacting to form a metal hydride); (4) conditions (temperature, pressure, etc) for releasing hydrogen at near room temperature that are mild and easily achieved; (5) conditions for manufacturing the metal hydride (pressure, temperature, etc required) that are mild, and (6) sufficient durability (performance not degraded after repeated hydrogen occlusion-release cycles).

Currently, research and development are underway for alloys based on the so-called rare earth metals, such as magnesium (Mg), titanium (Ti), vanadium (V), and various other alloys.

The table (p 40) shows the superiority of metal hydrides in comparison with liquefied hydrogen in the hydrogen storage volume per unit (milliliter). It is clear that the use of hydrogen energy depends on the practical application of metal hydrides with high energy densities using superior hydrogen occlusion alloys.

Hydrogen occlusion metals started at first with a unary system, namely one kind of metal, as in the table, then shifted to binary alloys such as titanium-iron, and have now come to quinary alloys.

Evaluated as a high-level achievement among the Japanese research results is the above-mentioned titanium-manganese alloy developed by Matsushita Electric. Interestingly, at about the time when the hydrogen occlusion alloys were first being studied in Europe and the United States in the latter half of 1960's, the above company unwittingly happened to become involved in research on the hydrogen occlusion of metal from a different research angle that is not at all related, and without being aware of the research being initiated in Europe and the United States.

In the process of studying thin-film formation techniques by sputtering (a phenomenon in which atoms of metal heated in low-pressure gas sputter into the gas and adhere to nearby solid surfaces), Director Hayakawa and others at the above-mentioned materials laboratory discovered that a marked hygroscopic effect is displayed by some thin-films among the titanium oxide thin-films formed under certain conditions. The totally new achievement of this development which was advanced was subsequently published in part in the journal of the Japanese Society of Applied Physics in September 1970. Such indirect results of the research became the lever for the development of a new hydrogen storage technique, and in the summer of 1978 Matsushita Electric Industrial Co announced that it had "succeeded in an epochal invention that can store hydrogen gas electrically in metals." According to trail calculations, the volume of hydrogen that can be occluded in 1 cubic centimeter is 2,000 cubic centimeters at 1 atmosphere. In other words, it is possible to hold 20 times more hydrogen than with the 100-atmosphere hydrogen cylinder then being used. However, this

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method of hydrogen occlusion is not the same as the so-called hydrogen occlusion alloy method, and because it requires high temperature to release the hydrogen, there has been no practical application.

**Development of Hydrogen Occlusion Alloys Making Progress**

However, stimulated by this development, the research group of Matsushita Electric became alert for the development of hydrogen occlusion before any other firms, and the first energy conversion technique research laboratory in Japan in the industry was established in affiliation with the central research laboratory. In 1974, they began to achieve good results with the above-mentioned titanium-manganese alloys, and more recently, they succeeded in developing a quinary alloy with special composition ratios of "titanium-manganese-zirconium-chromium-vanadium" among the alloys of titanium-manganese multiple element systems and attracted attention for their achievement of a superior hydrogen occlusion alloy.

Hydrogen automobiles are operated at the Billings [phonetic] Research Institute of the United States, Benz of West Germany, and Musashi Institute of Technology in Japan. The application of hydrogen to aircraft fuel is being studied in the United States. For motorcycles, three firms of the Sumitomo Metals Group--Kyodo Sanso, Sumitomo Seimitsu Kogyo, and Chuo Denki Kogyo--collaborated to modify a Honda 49-cc supercub which was test-driven this past January. Hydrogen was occluded in an iron-titanium alloy. A metal hydride of iron-titanium alloy with occluded hydrogen was loaded, and hydrogen fuel was released to run the machine. Sumitomo Metals has been reportedly advancing the development of hydrogen occlusion metals.

On 8 April, Nisho-Iwai revealed that it has signed a contract for a sales representative in Japan with Canada's INCO group, the world's largest nickel manufacturer, to market the hydrogen occlusion alloy they develop. Nissho-Iwai states that it has been decided to begin a full-scale, long-term undertaking.

In addition, among the Japanese firms, Japan Metals & Chemicals Co, Showa Denko, and others are beginning to undertake the development and production of hydrogen occlusion alloys. The start of a hydrogen occlusion alloy business is near.

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